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Cosmonauts Artsebarskiy, Krikalev Complete Fourth Month in Orbit

LD1809092291 Moscow TASS in English 0856 GMT 18 Sep 91

[By TASS correspondent Rena Kuznetsova]

[Text] Moscow September 18 TASS—The crew of the ninth main expedition on the Soviet "Mir" orbital complex, consisting of Anatoliy Artsebarskiy and Sergey Krikalev, has completed its fourth month in outer space. It is a routine day on the complex today. The cosmonauts are surveying the territory, adjoining the Kara-Bogaz-Gol Gulf in Turkmenia, the Hunger steppe in Uzbekistan and the Aral area of Kazakhstan. These surveys will help Soviet farmers to properly assess soil conditions and vegetation in these areas. Surveys are also being carried out of the Persian Gulf area for the purpose of evaluating the ecological conditions in that region.

Besides, the cosmonauts are getting ready the scientific equipment that will be used by the international Soviet-Austrian crew. The latter is expected to be orbited on October 2, 1991. In addition to the commander, this international crew will include two other cosmonauts—representatives of Austria and Kazakhstan. The first crew will include Soviet cosmonauts Aleksandr Volkov, Toktar Aubakirov (Kazakhstan) and Franz Fibek of Austria. The second—Aleksandr Viktorenko of the USSR, Talgat Musabayev of Kazakhstan and Klemenz Lotaller of Austria.

The commander of the ninth main expedition will return to the earth together with the international crew, while Sergey Krikalev will remain on the orbital complex as (flight)-engineer of the tenth main expedition.

As to rumours about the space complex, chief of the Cosmonaut Training Center Vladimir Shatalov has denied that the Soviet side is allegedly prepared to sell the "key" to the "Mir" station.

"I believe the orbital laboratory should not be sold. We must cooperate on mutually profitable terms and make joint use of it," General Shatalov said. "There are sufficient grounds for this," he said.

Mir Crew Conduct Geophysical Observations

LD2109005991 Moscow TASS in English 1313 GMT 20 Sep 91

[TASS correspondent report from Mission Control Center]

[Text] Moscow September 20 TASS—The crew of the Mir space station devoted the greater part of their working time this week to geophysical experiments.

As part of the extensive program to explore the earth's natural resources and the environment, Anatoliy Artsebarskiy and Sergey Krikalev carried out several sessions to photograph the southern areas of the country's European part, Kazakhstan and central Asian republics to define the state of the vegetation cover and appraise atmospheric pollution in major industrial centres.

The cosmonauts' studies today focused on gas-bearing areas of the Orenburg region, farms in Krasnodar territory and Kalmykiya.

The results of medical checks carried out by the cosmonauts using the Chibis pneumatic-vacuum space suit showed that both cosmonauts are in good health.

Cosmonauts Monitoring Regional Ecology

LD2509044391 Moscow TASS in English 1444 GMT 24 Sep 91

[Text] Moscow September 24 TASS—Soviet cosmonauts Anatoliy Artsebarskiy and Sergey Krikalyev today carried out research in geophysics and space technology.

The crew used the "Priroda 5" photographic system and the KAP-350 topographical installation to film the Black Sea coast of the Caucasus, Kalmykiya, western Siberia and Kazakhstan.

The research aims to estimate the ecological state of water basins, arable land and forests in specific regions of the Soviet Union.

In the afternoon, they began (a melt) within the framework of the Gallar installation program. The experiment aims to grow a high-quality monocrystal of the semiconductor material gallium arsenide.

Safety of Upcoming Mir Mission Questioned

917Q0188A Moscow IZVESTIYA in Russian 18 Sep 91 Union Edition p 4

[Report by L. Sergeyev: "The International Crew Will Make Do Without a Flight Engineer"]

[Text] **In Zvezdnyy Gorodok the presentation of the latest international space crew which is to set out for the Soviet orbital station Mir on 2 October has taken place. For the first time the crew includes three representatives of sovereign states.**

The main crew is made up of the experienced cosmonaut Aleksandr Volkov, and also representatives of Austria, Franze Fibek, and of Kazakhstan, Toktar Aubakirov. The backup crew is made up of Aleksandr Viktorenko, Clemens Lothaller, and Talgat Musabayev. The composition of the crew is somewhat unusual; it was expected earlier that researchers from Austria and Kazakhstan would go to the Mir station with a six-week interval between them. However, certain material complications being experienced by our space research organization have forced it to economize on one mission. In addition, it has become clear that the research program drawn up by scientists in Austria and Kazakhstan successfully complement each other.

Thus, hospitality is not suffering. But what about safety? For the first time a space vehicle will be launched essentially without a flight engineer, while two members of the crew have been trained for the mission under a shortened program. This means that during the mission, in the event of nonstandard situations, the crew commander will have to carry out not only his own direct duties but also the functions of the flight engineer. Will Volkov or Viktorenko be able to cope with a double burden? As the deputy chief of the cosmonaut training center, A. Leonov, said, the commanders have been trained in accordance with the program for cosmonaut-rescuers, who in the event of an accident can return their two comrades from orbit.

None of this means that the representatives of Kazakhstan and Austria are being sent on a mission with nothing to do. It is simply that their tasks are different, primarily scientific—monitoring the Earth's surface, astrophysics, medical and biological studies. In addition, the Austrians have paid out a considerable sum. And the negotiations about the mission for a cosmonaut from Kazakhstan have been going on for a long time. But as the old- timers in the ranks of the cosmonauts will recall, the candidate proposed several years ago was so large that it was impossible to make a space suit for him. This time this kind of irony has been eliminated. Suffice it to say that T. Abubakirov is an honored test pilot of the USSR and a Hero of the Soviet Union.

Coincidence or not, on the day when the crew with the Kazakh cosmonaut was presented in Zvezdnyy Gorodok, it was announced in Alma-Ata that a republic space agency was to be set up. Perhaps the second event was even more significant than the first. In a period when in the Union budget funding for space research is being sharply reduced and other radicals see no sense at all in it, the leaders of Kazakhstan, first and foremost the president of the republic, N. Nazarbayev, are supporting the development of this sector in every possible way, and believe that it has high scientific potential irreplaceable in solving economic problems and in developing an intellectual base for a technological breakthrough. A prestige space mission with a representative of Kazakhstan is merely one episode in a broad program of space research planned in Kazakhstan. This program provides for the introduction of hi-tech space technologies in production here on Earth, studies of water resources, pasture, and agricultural land, and fundamental scientific research. The Institute of Space Research was recently set up in Alma-Ata. A representative delegation of American industrialists closely linked to NASA recently visited Baykonur. It became clear from our conversation that the visit to Kazakhstan had rewarded them with rich ideas about cooperation with Soviet space research, but that there was only one complication, namely, it is not clear who sets that policy today.

The international crew will be in orbit for a week. A change in the initial flight plan has led to a situation in which Sergey Krikalev will remain on the Mir station for another half year. During the landing the international crew will be led by A. Artsebarskiy.

Preparations for Joint Mission to Mir

LD3009133791 Moscow TASS in English 1124 GMT 30 Sep 91

[By TASS correspondents Yury Konorov and Vladimir Khrustov]

[Text] Baykonur Cosmodrome September 30 TASS—The regular international space expedition, expected to begin within two days from now, arouses particular interest among mass media representatives. Two space researchers will work on board the Soviet "Mir" scientific complex for the first time—a representative of Austria and an envoy of sovereign Kazakhstan, where the country's main cosmodrome—Baykonur—is located.

More than 180 Soviet and foreign journalists, including more than 40 Kazakh pressmen, have already been accredited at the cosmodrome's press center. This was stated on Sunday evening by Kazakh minister for the press and information Kuanysh Sultanov and head of the press service of the USSR Defense Ministry's space units Colonel Aleksandr Radionov. Sultanov informed representatives of the press that henceforth "space journalists" will have to get accreditation certificates from the Kazakh Ministry for the Press and Information in order to be able to cover Baykonur events.

The working day of journalists began with dawn today. They watched how the carrier-rocket with the "Soyuz TM-13" transport vehicle were moved out of the assembly and testing shop to the starting position. The flight is expected to last eight days. The two spacemen will spend six of them on board the "Mir" complex. While Commander Aleksandr Volkov takes over from Anatoly Artsebarskiy, Toktar Aubakirov of Kazakhstan and Franz Viehboeck of Austria will carry out some difficult scientific programs, specially prepared for them by Austrian and Kazakh scientists. They include medical, technological and geophysical research and experiments, long-distance sounding of the earth's surface and the atmosphere.

Aubakirov and Viehboeck will return to the earth together with Anatoliy Artsebarskiy, commander of the crew that is now working on the orbit. Alexander Volkov and board engineer Sergey Krikalev will continue their space duty until March 1992.

We have forestalled events by indicating the names of future expedition members. The state commission will meet tomorrow to decide the composition of the crew. The start is fixed for 7.59 a.m., October 2.

Progress M-9 Capsule Returns to Earth

LD3009151991 Moscow TASS in English 1328 GMT 30 Sep 91

[Text] Moscow September 30 TASS—The entry capsule of the Progress M-9 transport spacecraft has been successfully returned to Earth today.

The capsule delivered research materials from orbit, prepared by two Soviet cosmonauts, Anatoliy Artsebarskiy and Sergey Krikalev, aboard the Mir orbiting Soviet space station.

The transport disengaged from Mir at 03.54 Moscow time [0054 GMT]. The M-9 carried the capsule through its descent trajectory but separated from the craft on reentry where the M-9 burnt up.

The capsule completed its descent by parachute and made a soft landing in the designated landing area at 10.18.

Anatoliy Artsebarskiy and Sergey Krikalev continue their mission and are now preparing to welcome a Soviet-Austrian research crew, arriving to the station soon. Health of the both cosmonauts is reported satisfactory.

TV Coverage of Soyuz TM-13 Launch

PM0810094391 Moscow Central Television First Program Network in Russian 1900 GMT 2 Oct 91

[From the "TV Inform" newscast: Report by P. Orlov and A. Gerasimov]

[Text] [Announcer] At last a day which has started with good news. The Soyuz TM-13 craft with an international crew on board was launched successfully at Baykonyr today. Crew commander is USSR Cosmonaut Aleksandr Volkov, and the cosmonaut researchers are Kazakh Takhtar Aubakirov and Austrian citizen Franz Viehboeck. [unintelligible exchange between crew and ground control]

[Orlov] The order has gone out to initiate the launch procedure [klyuch na start]. This means the automatic system controlling launch operations has been switched on.

A very strong wind is blowing in the steppe. Doubts have arisen as to whether the launch will go ahead. However, Commander Aleksandr Volkov reassured everyone by saying that the rocket is not swaying. This means that all is well.

[Crew Commander Aleksandr Volkov, with German translation in the background] The program of the visiting expedition is, as always, full. You might even say it's more than full. Two research cosmonauts will be at work at once. The scope of the station has not changed, but the number of experiments to be carried out has more or less doubled. This was bound to produce some complications. However, we have sought to sidestep them. During the training sessions in the simulators, we have divided up our time in such a way as to fit in the whole program, and I believe we will be able to do everything as planned. We have even managed to set some time aside in case we need to catch up on something.

[Gerasimov] When Takhtar Aubakirov and Franz Viehboeck leave the station, Aleksandr Volkov and Sergey Krikalev will first test the docking system. Two spacewalks are scheduled for later on.

[Unidentified voice] Lift-off. [Video shows launch]

[Announcer] A detailed report on the lift-off of the Soyuz TM-13 spacecraft will be broadcast immediately after the evening news bulletin.

Gorbachev, Yeltsin Send Greetings to Space Crew

LD0410173791 Moscow TASS in English 1517 GMT 4 Oct 91

[Text] Moscow October 4 TASS—Soviet President Mikhail Gorbachev and Russian President Boris Yeltsin on Friday [5 October] sent greetings to the Soviet-Austrian crew of the Soviet orbiting station Mir.

There are currently five cosmonauts working on board the station: Anatoliy Artsebarskiy, Sergey Krikalev, Aleksandr Volkov, Toktar Aubakirov and Franz Viehboeck.

"You have the honour to perform the first Soviet-Austrian space flight. I congratulate you on the successful docking and the beginning of joint work on board the orbiting station Mir," Gorbachev said.

The Soviet Union and Austria have long-standing friendly ties. Joint work of Soviet and Austrian cosmonauts in orbit starts a new stage of mutually beneficial cooperation between both countries, the message says.

Gorbachev greeted Aubakirov as the first representative of Kazakhstan to perform a space flight.

Yeltsin expressed hope the flight will help advance scientific and technological progress and promote friendship and mutual understanding between the peoples of Russia, Kazakhstan and Austria.

The Soviet and Russian leaders wished the cosmonauts fruitful work and safe return to earth.

Joint Crew Performs Experiments

LD0710155191 Moscow TASS in English 0928 GMT 7 Oct 91

[By TASS correspondent Vladimir Khrustov]

[Text] Mission Control Center October 7 TASS—Aleksandr Volkov, Toktar Aubakirov and Franz

Veihboeck went into their fourth day of work aboard the Mir space station.

As before, they continue to concentrate on implementing the two researcher cosmonauts' scientific program. Viehboeck is performing the medical experiments "Bodyfluids", which is designed to explore the reaction of man's circulation system to irritants in zero-gravity conditions, and "Son" (sleep) and also the technological experiment "Logion" to test ion radiators. In addition, Viehboeck plans to photograph Austria's territory today.

Aubakirov will conduct the "Batyr" and "Son-B" medical experiments. The first is designed to study the influence of special respiratory exercises.

In the afternoon, the cosmonauts will talk to Soviet and Austrian radio commentators.

Austrian, Kazakh Cosmonauts Continue Experiments Aboard Mir

LD0810191691 Moscow TASS in English 1628 GMT 8 Oct 91

[By TASS special correspondent Yury Konorov from the Mission Control Center]

[Text] Moscow October 8 TASS—The Soviet-Austrian crew has almost completed its fifth day on board the Mir orbiting station.

Austrian cosmonaut Franz Viehboeck today conducted the "Son" and "Audomir" medical experiments, as well as other research in accordance with his scientific program.

The research aims to study the influence of zero gravity, human isolation, and other space factors on various functional changes in the human body.

Tokhtar Aubakirov filmed the territory of his republic, Kazakhstan, alongside other research. The films will enable a detailed analysis of the Kazakh agricultural resources and will help to estimate the state of soils.

Unfortunately, a TV bridge with Kazakhstan, which has been scheduled for this morning, was not held. The Kazakh cosmonaut was to exchange opinions with agricultural experts on the work he is doing.

All the data obtained has been transmitted to the Mission Control Center, from where it will be delivered to Kazakh specialists.

'Progress M-10' Cargo Spacecraft Launched

LD1710043491 Moscow TASS International Service in Russian 0337 GMT 17 Oct 91

[Text] Moscow, 17 Oct (TASS)—In accordance with the program for further work by the "Mir" scientific research complex, the automatic cargo craft "Progress M-10" was launched in the Soviet Union at 0205 Moscow time [0005 GMT] 17 October 1991.

The delivery aboard the "Mir" manned complex of expendable materials and various cargos is the aim of the launch.

The craft is also equipped with a ballistic capsule, which is intended for returning materials and the results of scientific research to earth.

According to telemetry data, the on-board systems of the cargo vessel are operating normally.

'Progress M-10' Fails to Dock With Mir

LD1910081891 Moscow TASS in English 0724 GMT 19 Oct 91

[Text] October 19 TASS—Mission Control Center. A Soviet cargo spacecraft carrying supplies for the orbiting station failed to link up with the platform after its approach program shut off automatically, but is in controlled flight and technicians are working out a way to deal with the problem.

It cropped up when the 'Progress M-10' freighter, launched on October 17, was maneuvering, as programmed, to get closer to the Mir station. Telemetry data and trajectory measurements showed that all on-board systems were operating as normal and everything was going according to plan. But then the approach mode was automatically switched off 150 metres from the platform.

'Progress M-10' is now in controlled autonomous flight. The Mission Control Center said it will announce its further program of work with the spacecraft later.

Mir Cosmonauts Observe X-Ray Sources

LD2910142991 Moscow TASS in English 1150 GMT 29 Oct 91

[Text] Moscow October 29 TASS—Soviet cosmonauts Aleksandr Volkov and Sergey Krikalev will stage a series of astrophysical observations from the Mir space station today in search for galactic and extra-galactic X-ray sources, the space control mission has announced.

Under a geophysical research plan, a land surface photography series has been performed, using high definition cameras Priroda-5 and KAP-350.

The crew is also conducting medical experiments using scientific equipment developed by Austrian specialists to measure the effects of weightlessness on the cosmonauts' eyesight and vestibular system.

Another experiment, Diagramma, is designed to measure atmospheric characteristics around the space station.

Cosmonauts Continue Research in Materials, Astronomy

LD0611132591 Moscow TASS International Service in Russian 1217 GMT 5 Nov 91

[Text] Flight Control Center, 5 Nov (TASS)—Today a process of growing in weightlessness another monocrystal of gallium arsenide with improved structural and electrophysical characteristics was completed on the "Gallar" technological plant on board the "Mir" orbital complex.

In accordance with the research plans of astronomy in space, the cosmonauts Aleksandr Volkov and Sergey Krikalev will have to take a number of photographs of certain parts of the celestial map during the course of the day, with the help of the "Glazar-2" telescope which registers emissions in the ultraviolet part of the spectrum.

The program for the following week includes work on outer space materials technology, and astrophysical and geophysical research. The cosmonauts will also continue the operations for further supplying of the manned complex with the equipment brought by the "Progress M-10" ship.

Experiments continue with the use of automatic scientific apparatus. The control center receives information about physical processes occurring in the ionosphere and the magnetosphere of the Earth, about spatial energy characteristics of cosmic emissions, and about the radiation situation on the route of the orbital complex, through telemetric channels .

Cosmonauts Continue Research Program

LD1111154591 Moscow TASS in English 1336 GMT 11 Nov 91

[Text] Flight Control Center November 11 TASS—Cosmonauts Aleksandr Volkov and Sergey Krikalev, now working on the "Mir" orbital complex, conducted geophysical and astrophysical surveys, as well as space material studies, in the period from November 6-10. The "Mir" station was orbited on February 2, 1986.

The cosmonauts, members of the 10th expedition, have carried out surveys of vast areas of the ground and ocean surface by means of the "Priroda-5" photographic installation and the Kap-350 topographic apparatus. Used also during studies of the earth's natural resources and the environment were video-spectral instruments, installed on a telecontrolled platform of the "Kvant-2" module.

Today, the cosmonauts are to smelt germanium on the "Optizon" technological installation, which heats samples of semiconducting materials by focused rays of energy from electric light sources.

In the morning, Aleksandr Volkov and Sergey Krikalev were subjected to medical checks. Both feel fine.

Commentary on 'Sofora' Girder Experiment, Diagram of Structure

917Q0165 Moscow PRAVDA in Russian 29 Jul 91 p 2

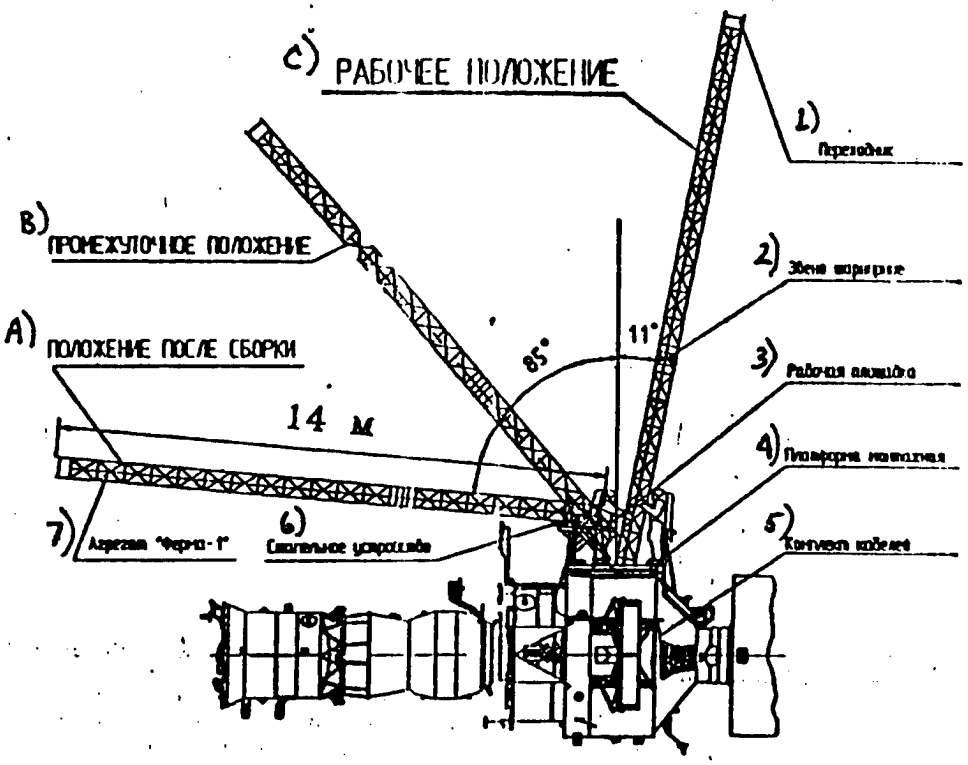
[Article by PRAVDA correspondent A. Tarasov: "Goodbye, Space Suit?: Report from the Flight Control Center"; first paragraph is PRAVDA introduction]

[Text] **Nearly 24 hours in open space, and Sofora is ready. True, it was a 24-hours period that took four sunsets—going from the base to the flag at the top of the 14-meter trusswork mast, which Anatoliy Artsebarskiy was holding onto, under the watchful remote eye of Sergey Krikalev, when he gave a short, but heart-felt speech.**

True, the fourth, nearly seven-hour construction EVA began on Saturday morning with a frightful picture. One of the space suits suddenly broke away from the station and flew away into space. One simply wanted to cry out, "Guard, stop it!" But the space suit, fortunately, was empty, a used-up shell. Engineer Mikhail Balashov, its curator from the Tomilino Zvezda Scientific Production Association, said without hesitation that that was space suit No. 10, one of the autonomous firstlings of the firm. It has to its credit nine EVAs, five of which were made by Musa Manarov during two of his missions. Two other EVAs were made by Aleksandr Serebrov, and one each was made by Gennadiy Strekalov and Jean-Louis Chretien. At any museum in the world, people would tear at such an exhibit with their bare hands; it would sell with delight at an auction. But what about the school of young cosmonauts? It is a pity that it went out that way, lost forever—into the upper layers of the atmosphere. However, perhaps it will be lucky—perhaps it will make a smooth landing somewhere. It is heat-resistant, after all. So watch the sky over your head. Watch it well....

Availing myself of the opportunity, I conducted an quick interview of some of the guests and participants: "Which of your acquaintances would you like to see in that space suit now?" The responses were strikingly unanimous: "I'm not such a bloodthirsty person," "I don't want to be a murderer." What joyful friendliness.

Meanwhile, the assembly of the last five cell-like sections with the hot clamping of the joints was in full swing. From a distance it is even beautiful—they soar like birdmen in the working zone. But the specialists know that it's a little different in space. All the dimensions and calculations are the same, and the gloves and space suits are the same, but it's only at home, in the simulators, that they were able to work in the anchor-holder and reach all the points. In weightlessness they couldn't—they were just a few millimeters short. They had to attach themselves with their legs up in the air. And all the work is done with the arms—"walking" from hand-hold to hand-hold, staying in place, doing the damn rigging, doing the damn mechanical work. One cell of Sofora is 100 "hand-over-hands" in gloves. Every time they pull their arms out of the sleeves into the daylight, you see bruised wrists, bruised elbows, bruised shoulders—there's not a single spot that hasn't been battered. And



The Sofora Experiment

Key: A—Position after assembly; B—Intermediate position; C—Operating position; 1—Adapter; 2—Hinged section; 3—Working area; 4—Assembly platform; 5—Set of cables; 6—Assembly device; 7—Ferma-1 [Girder-1] unit

yet, every time they go out, they exhibit such confidence, tirelessness, and even grace in the difficult and intricate work.

They wanted to raise the flag themselves. Before they raised a more substantial load. No one forced them. On the contrary, on Earth, people had various attitudes about it. Some people felt that it wasn't the time for flags, that flags, like emblems and fanfares, are not highly thought of, and that the people would again begin to grumble about that kind of money being thrown into space for the sake of the flag. Other people were asking, What is this here? The Americans put their flag up at every roost, and they're not embarrassed. They put it up at home, at the office, on the moon. Still others were saying, The Americans have something to be ashamed of.... And so on.

While Earth and the leadership oscillated, someone in a truck, by private arrangement, left a package with a flag that had been bought right at the Baykonur commissary. The cosmonauts themselves reinforced it for weightlessness, fashioned an attachment out of yarn, and finally unfurled it.

No matter what you think, it looks fine against the background of the chasm of space and the silver spacecraft masts and superstructures. With its innocent emblem, a sickle and hammer. And Anatoliy, having climbed to the top, had every right to say that things are hard for the space program right now, but the difficulties will pass, and the work—every practical step that is taken—will remain forever.

Yes, the sidelong glances are testing the space program. But a professional, no matter what his work, must do a good job. And the job here is to explore the environs around the Earth. Would that we had professionals like these in all our occupations.

The little Sofora may turn out to have a great future. It has many developers, but it also has a personal inventor. Designer Sergey Trusov has also gone down in history: the name he came up with won in the competition for the name of the experiment. First of all, it's an exotic, but strong, red tree. That fits. Second, with proper diligence an appropriate abbreviation was also found. It stands for "Sooruzheniye fermennogo orbitalnogo agregata" [construction of a trusswork orbital unit].

I congratulate all the authors, who can't go any farther out: the Earth is behind them.

News Conference on Soviet-Austrian Space Flight

LD2509211691 Moscow TASS in English 1720 GMT 25 Sep 91

[By TASS correspondent Vladimir Smelov]

[Text] Vienna September 25 TASS—Scientific and technical cooperation between the Soviet Union and Austria has literally reached cosmic heights, speakers emphasised here today at a news conference dealing with the forthcoming space expedition, to begin on October 2.

A Soyuz TM-13 spaceship will deliver two Soviet cosmonauts and an Austrian one to the orbital station Mir; they will jointly work in orbit for nine days.

Who exactly will be the first "austronaut" will become known immediately before the launch. Franz Viehboeck, an engineer, is so far the first candidate for the flight. His back-up pilot is Clemens Lothaller, a physician. Both are from Vienna.

The two austronauts are now at the Baykonur Cosmodrome, ready for the flight. They will bring not only "working tools" to orbit but also souvenirs and the state flag of Austria that would be after the flight presented to President Kurt Waldheim.

A farewell speech before the launch will be delivered by Austrian Federal Chancellor Franz Vranitzky who will visit Baikonur on October 2.

Otto Zellhofer, the Austrian side's director of the space project christened "austroworld," described the forthcoming space flight as a great event.

Space research instruments made in Austria have already been brought to the Mir station and performed successfully under tests, Zellhofer said.

By means of the instruments the astronauts will perform experiments which will be not only of scientific importance but, in prospect, of practical benefit as well, he added.

The Soviet side has rendered much assistance and allround support in organizing and preparing the flight, Willibald Riedler, scientific director of the project, told TASS.

This event will open up a new page in bilateral scientific and technical cooperation, he emphasised. Riedler voiced confidence that this cooperation would continue to follow an upward trend subsequently as well, in the interests of peace and for the benefit of the peoples of the Soviet Union and Austria.

Soviet-German Flight May Be Postponed

LD2709165191 Moscow TASS in English 1508 GMT 27 Sep 91

[By TASS correspondent Nikolay Kalintsev]

[Text] Bonn September 27 TASS—A Soviet-German space flight to the Soviet orbiting station Mir scheduled for next March may be postponed due to political changes in the Soviet Union, German Minister of Research and Technology Heinz Riesenhuber told NORDSEE-ZEITUNG on Friday.

Riesenhuber stressed this will not affect space cooperation between both countries.

Small Solar Sail Spacecraft for Regatta Project

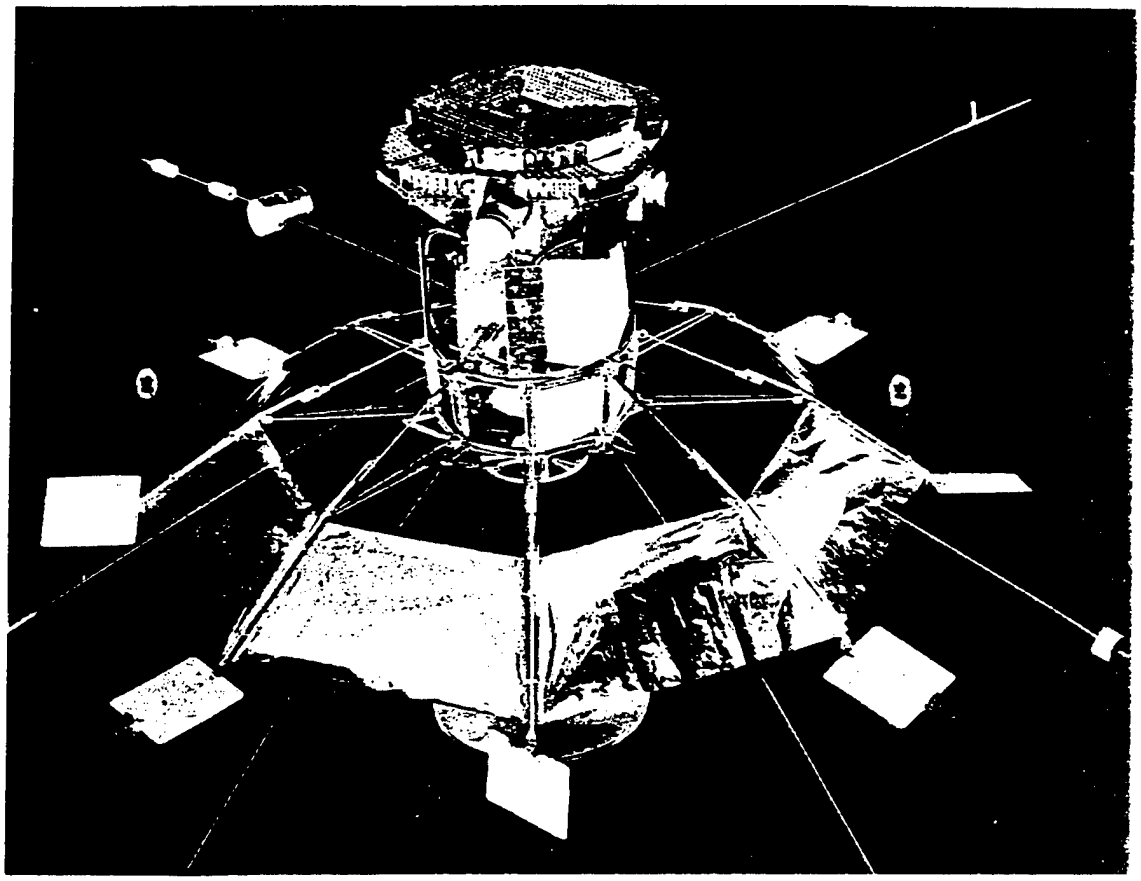
917Q0116 Moscow ZEMLYA I VSELENNAYA in Russian No 1, Jan-Feb 91 pp 3-8

[Article by G. A. Avanesov, doctor of technical sciences, and V. I. Kostenko, candidate of technical sciences, both from the USSR Academy of Sciences' Space Research Institute, under the rubric "Space Program": "A Space Flight Under Solar Sail"; first paragraph is source introduction]

[Text] **Scientists from the USSR Academy of Sciences' Space Research Institute are working out the details of the Regata [Regatta] project, which calls for the development of a Small Space Laboratory, for which light pressure will be used to effect attitude control and stabilization.**

Despite the rapid development of space technology and the appearance of ever newer types of space vehicles, problems that go beyond the framework of the capabilities of available equipment come up everywhere. That is especially true of certain fields of science such as the investigation of solar-planetary relationships and space-based astrometry. The investigation of space plasma, for example, is possible only with an ample, intrinsic spacecraft "cleanliness" that is not provided on multipurpose space vehicles. In space-based astrometry, the main factor that determines the accuracy of measurements is the determinability of the space vehicle's proper angular movement. It is attained only if the mechanical perturbations of the vehicle are minimized. Small, inexpensive vehicles are needed in such instances for solving the problem of the "single experiment." Important prerequisites for the development of such space vehicles are the overall growth in the level of the technology, the accessibility of state-of-the-art structural materials, the accumulation of experience in the designing of instruments that operate in open space, and the further development of microelectronics and communications technology.

An example of a "single-experiment" space vehicle is the Small Space Laboratory (SSL) under development in the USSR Academy of Sciences' Space Research Institute. The force of solar light pressure is used to effect attitude control and stabilization for the spacecraft. That has made it possible to simplify the auxiliary systems, reduce their mass in relation to the payload, increase reliability, and reduce costs. Payload can be as high as 50 percent of SSL mass.



Mock-up of the Small Space Laboratory (SSL)

Stabilization System

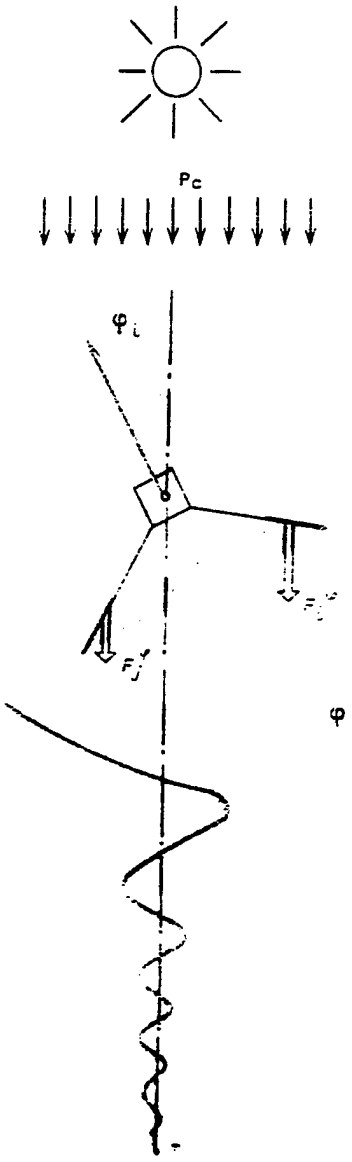
To a large extent, the passive attitude-control system, which makes use of the forces of light pressure, determines the appearance of the space vehicle and the range of its possible applications. The interaction with the light flux is effected by the solar sail, which is made up of two parts—an immobile part (the stabilizer) and a mobile part (the rudder).[1] In addition to the sail, the attitude control system includes a liquid nutational-oscillation damper. The SSL's longitudinal axis is pointed at the sun. The remaining two axes can remain immobile in the orbital heliocentric coordinate system (constant solar-stellar orientation), or they can slowly rotate (up to several revolutions per 24-hour day) around the line to the sun (constant solar orientation). Both modes are identically favorable for maintaining constant temperature conditions on the vehicle and for operating the power supply system. The preservation of the solar orientation is ensured by a single stabilizer (without the assistance of the rudders). By changing the sail's geometry (by turning the rudders), it is possible to spin the SSL at the needed angular velocity. Rudders are also used in the initial damping phase, when it is necessary to suppress the angular velocities produced by the vehicle during separation from the upper stage. We would note that the study of the dynamics of a space vehicle stabilized by solar light pressure is an area of independent scientific interest.

The specifics of the SSL's attitude control and stabilization make it possible to use this space vehicle most effectively in the regions of outer space where the gravitational effects on the SSL's attitude from Earth and other celestial bodies are substantially smaller than is the influence of the solar light pressure. In near-Earth space, such conditions are reliably satisfied at distances of more than 5 Earth radii [R].

Some of the experiments planned for the SSL require rapid rotation of the sensors. Therefore, certain modified versions of the SSL have a massive rotating platform on which the scientific and auxiliary equipment are mounted. The platform's axis of rotation is pointed toward the sun and coincides with the space vehicle's longitudinal axis. The mass of the payload on the platform amounts to 35-45 kg. The spin rate amounts to up to 15 revolutions per minute [rpm]. The gyroscopic moment that acts on the space vehicle from the platform is compensated for by a flywheel that rotates toward the platform.

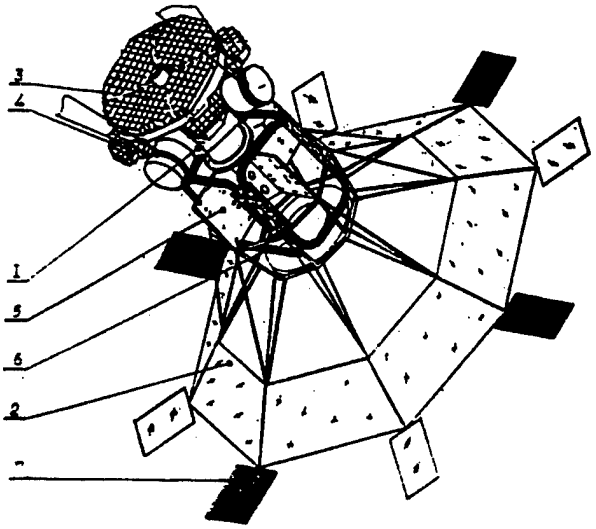
Regata-Plazma

In the first stage of the use of the SSLs (1994-1997), the most important project will be the Regata-Plazma [Regatta-Plasma] project. The project's goal is the investigation of solar-planetary relationships (solar activity, the mechanisms for the transmission of solar effects through the interplanetary medium, and the reactions of near-planet space to solar disturbances).



Principle of the SSL's Orientation on the Sun
In the initial stage of the SSL's flight, after separation from the rocket's upper stage, the SSL's longitudinal axis could be deflected from the line to the sun by angle φ_i. Because of the light pressure forces P_c, the solar sail is subject to forces F_i^{φ} and F_j^{φ}, which differ in magnitude depending on the sail's position and which strive to align the SSL's axis toward the sun. Also shown is the law of possible movement of the SSL's longitudinal axis (angle φ) with respect to the line to the sun as a function of time. With an initial angle of φ approximately equal to 40°, for $\tau = 50$ hours, the magnitude of the angle is approximately 1°.

Solar activity has long been studied with ground facilities and, in the last 20 years, with the aid of space



General View of the SSL in the Regata-Plazma Project

A basic feature of this type of SSL is the presence of a rotating platform (1) and a sail (2) made of a reflecting "mirror-like" material. The SSL's longitudinal axis is pointed toward the sun by the solar panel (3), which is the primary power source. The rotating platform (15 rpm) has its own solar panels (4). The scientific and auxiliary equipment is located on a temperature-controlled frame (5), to which is attached the liquid damping device (6), which suppresses the SSL's lateral oscillations. In order to compensate for pointing errors, as well as for programmed turns and rotation around the SSL's longitudinal axis, controllable solar sails (7) are used, and they have a different covering on each side: a "mirror-like" coating on one side, and a "black" (absorbent) coating on the other.

vehicles that enable investigation of the ultraviolet and X-ray sections of the spectrum and direct recording of corpuscular radiation.

To this day, however, the mechanism underlying the cyclic nature of solar activity and the mechanism underlying solar flares and the acceleration in them of particles to extremely high energies remain unclear, methods for predicting solar flares have not been developed, and the experimental study of the sun's internal structure is just beginning. There are quite a few problems still to be solved by the experimenters in the investigation of the solar corona as well. Despite the enormous successes in the study of the solar wind, there is still too little known about its spatial structure and a number of other characteristics.

Of especial interest are the plasma physics experiments in support of the Mars exploration program. Material must first be gathered and a stockpile of research created for solving scientific questions of the Mars program. Second, the radiation safety of flights to Mars must be ensured for future cosmonauts.

Mars and Earth are very close to each other. It is clear that the principles that govern the solar-terrestrial relationships also determine Mars's relationship with the Sun. That is why many questions associated with the Mars program can be solved in the course of experiments in near-Earth orbits. All that is necessary is that the space vehicles spend the greater part of their time outside the Earth's magnetosphere.

As conceived, the Regata-Plazma project calls for the creation in the years 1994-1997 of an experimental satellite system. The system will include 4-5 SSLs set out along a line that runs through the Earth and the sun (the forward libration point, an equatorial orbit, the near tail (20 R), the middle tail (60-70 R), and the rear libration point). That system would be an extended chain of satellites, and it would ensure a multiprobe investigation of the magnetosphere jointly with the European Space Agency's Cluster and Soho satellites, as well as, possibly, with NASA's Polar and Wind satellites and the Japanese Geotail satellite. Corrections of the measurements which will be obtained on those space vehicles, plus their joint analysis, which would simultaneously use ground-derived data and data from low-orbit satellites, will make it possible to advance substantially our understanding of the nature of the solar-terrestrial relationships and of the physics of the magnetosphere and to solve physics problems that researchers are encountering in astrophysics, plasma physics, and thermonuclear research.

Regata-Astro

It is also being proposed that, during that same period (1994-1997), an SSL be used for the realization of the first stage of the Regata-Astro project. That project's goal is the performance of astrometric and radiometric space-based studies of the stars and other celestial bodies.

Solving astrometric problems from space platforms has a number of substantial advantages:

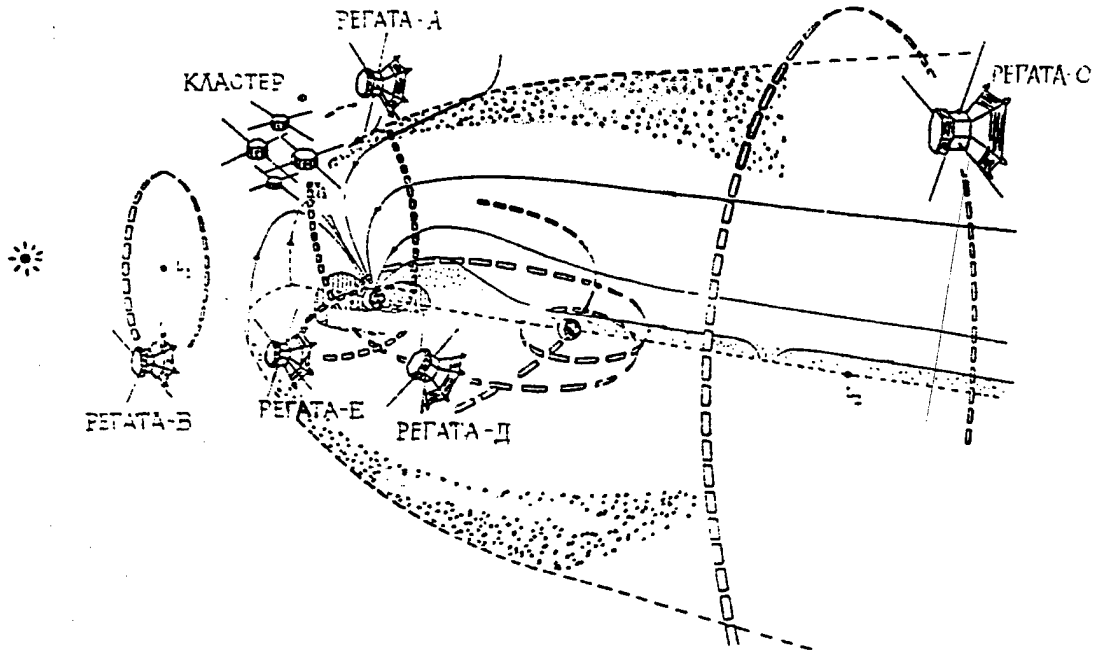
it precludes the influence of the Earth's atmosphere, which causes the refraction, dispersion, and absorption of light

it precludes the influence of the Earth's gravitational field, which causes deformation both in the space vehicle's structure and in the optical instrument

it presents the opportunity to obtain all the data in a single coordinate system

researchers no longer need to take into account the parameters of the Earth's rotation, the inaccurate knowledge of which degrades over time the accuracy of the reference coordinate system

observations from a space vehicle can be conducted almost continuously over many days, months, or even years



Experimental Satellite Network for the Regata-Plazma Project

Key: 1. Cluster vehicle—2. Regata-A vehicle—3. Regata-Ye vehicle—4. Regata-D vehicle—5. Regata-V vehicle—6. Regata-S vehicle—7. Libration point L_1—8. Libration point L_2—9. Sun—10. Earth—11. Moon
The system is intended for plasma physics research on the interaction of the sun and the Earth in the following areas:
Regata-A Project—the SSL in polar orbit interacts with the European Space Agency's space vehicle (ESA, Cluster Project)
Regata-Ye Project—the SSL is in an orbit close to equatorial. The research is conducted within the Earth's radiation belts
Regata-D Project—the SSL is in an orbit with a fly-around of the Moon
Regata-V Project—the SSL is in an orbit around the libration point L_1 located in front of the Earth (approximately 1.5×10^6 km away)
Regata-S Project—the SSL is in an orbit around the libration point L_2 located behind the earth (approximately 1.5×10^6 km away)

Thanks to that, the accuracy of the star catalogs being created will be enhanced considerably. Precision astrometric measurements made from a space vehicle will make it possible to establish a coordinate base for studying the development of the kinematics and dynamics of the solar system. The aggregate of the data obtained on the proper motions, parallaxes and radiometric characteristics of various types of stars will expand our knowledge in the field of stellar astronomy and astrophysics (refinement of the scale of distances throughout the universe, determination of star radiant emittance and mass, and investigation of the structure, dynamics, age, and evolution of the galaxy). Astrometric measurements accurate to within thousandths of an arc second (which is unattainable for ground-based instruments) will produce an opportunity for studying certain relativistic effects as well (in particular, the relativistic shifts of the perihelia of Venus and Mars).

The practical value of the data from space-based astrometry and radiometry consists, first of all, in a substantial enhancement of the accuracy of star tracking and astronavigation of space vehicles, as well as the precision determination of the coordinates of man-made and natural celestial objects. In particular, during flights to Mars, enhancement of guidance accuracy will make it possible to use aerodynamic braking of a space vehicle efficiently and to increase the weight of the payload through a reduction in the fuel supply.

The idea of using an SSL to arrange astrometric instruments is based on the following basic propositions:

The motion of an SSL relative to the center of mass ensures a complete survey of the stellar sky and optimal conditions for determining the annual parallaxes and proper motions of the stars. It is important that the space vehicle's constant orientation with respect to the sun

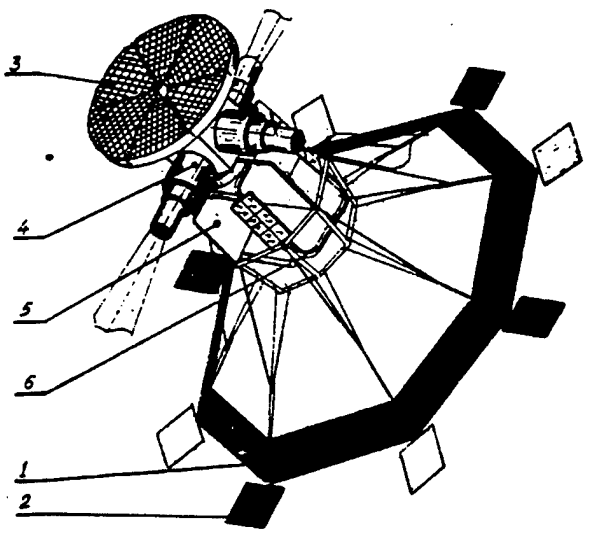
guarantee a constancy of thermal conditions on the vehicle and, consequently, the absence of thermal deformations of the measuring instruments.

The SSL's structural design provides for modifications of the base structure. Thanks to the selection of orbits and operating conditions of the vehicle's systems, the SSL's angular motion acquires a high degree of determinability. That, in turn, opens up the possibility of using statistical processing of large blocks of measurements that combine observations widely spaced in time of one and the same stars.

When astrometric measurements are made, the exact position of the instrument must be known at the moment of measurement, or it must be known when the measurements are being processed. Traditionally, the first approach is used in astrometry. The high degree of determinability of the SSL's angular motion makes it possible to use the second approach, in which the positions of the stars, the instrument's parameters, and the space vehicle's orientation are determined jointly, in the same process of the statistical processing of the measurements.

The choice of SSL orbit in the Regata-Astro project is subject, first and foremost, to the requirement that perturbations in the angular motion be minimized. Also taken into consideration, of course, are the conditions for organizing communications with Earth. That is the reason for the requirement that, during its active lifetime (five years), the space vehicle come no closer to the Earth than 1 million kilometers and move no farther away from it than 10 million kilometers. The insertion into the operating orbit from a parking orbit must be accomplished by a single firing of the upper stage, and the subsequent flight must proceed without any orbital corrections. That condition and others are satisfied by quasisatellite orbits (QSO) within the sun-Earth system. Such orbits are much closer to the Earth than to the sun, but they are located far beyond the boundaries of the Earth's sphere of influence (movement along them is determined primarily by attraction not to the Earth, but to the sun). A QSO in the Regata-Astro project has a semi-minor axis of 5 million kilometers and an inclination to the plane of the ecliptic of 10°. The space vehicle's distance from Earth varies within the range of 2-10 million kilometers.

The astrometric SSL's basic characteristics, its orbit, and its attitude control make it possible to use this type of space vehicle effectively to solve a number of other problems, in particular, to map the celestial sphere in the thermal IR and millimeter ranges of electromagnetic waves. The mapping of the celestial sphere in the thermal IR region is best done in three spectral bands (2-7 μm, 10-12 μm, and 15-20 μm) with a spatial resolution of six minutes, with coverage of stars extending to the 15th stellar magnitude. Radio brightness maps of the celestial sphere can be compiled on the basis of measurements in the regions of three wavelengths (1.0-1.5-3.0 mm) with a spatial resolution of no worse than 0.5.[1]



General View of the SSL in the Regata-Astro Project

In this project, it is necessary to minimize the disturbing factors for the SSL. To do that, orbits are selected which are several million kilometers away from Earth, and certain structural changes are introduced. The main sails (1) are made of absorbent "black" materials, while the controllable sails (2) are made of a material with a different coating on each side (a "black" coating and a "mirror-like" coating). Shown in the figure are the solar panel (3), the television star cameras (4), the instrument rack (5), and the damping device (6). The SSL's slow rotation (1 revolution per day) around the longitudinal axis (aligned toward the sun) and the use of four star cameras (4) (installed in the plane perpendicular to the direction toward the sun) will make it possible to obtain maps of the stellar sky over six months of the orbital flight.

Mapping the celestial sphere in the thermal IR and millimeter ranges will make it possible to detect and investigate radiation sources not recordable in the visible near-IR region, study star-formation processes, and solve other problems of astrophysics, stellar astronomy, and cosmology.

To solve those astrophysical problems, two SSLs are needed—one with radiometric equipment, and a second with infrared equipment. They can operate in identical orbits and have the same attitudes adopted for the Regata-Astro project's SSLs.

Flights to Asteroids and Comets

It has been proposed not only that, in subsequent stages of the realization of the Regata project (after 1997), the plasma physics and astrometric space-based research

should be continued, but also that an SSL should be used as a platform for carrying out a rendezvous with and fly-by of small bodies of the solar system and for conducting an astrophysical study of them.

To be able to track small bodies (asteroids and cometary nuclei) and, what is more, to be able to land on them, the SSL must be equipped with a rocket engine capable of producing a high-thrust impulse. Strictly speaking, an SSL could, in theory, rendezvous with a small body by using a solar sail; but, for all practical purposes, that precludes the possibility of rapid orbital correction. That is why close-in approaches will have to be made with vernier rocket engines.

A space vehicle's trajectory can be selected such that the spacecraft makes a fly-by of several small bodies with one launch operation. For a space vehicle with a sail propulsion system, there are, as a rule, two launch operations (the lift-off resulting in a fly-by of the first asteroid, and a gravitational maneuver in the Earth's field resulting in a fly-by of a second asteroid). The time span for a flight along such trajectories amounts to one-two years.

It would be interesting to send to a small body a space vehicle that had earlier been inserted into an orbit at the edge of the Earth's sphere of influence—for example, into a halo orbit. Such a possibility was first demonstrated by the ISEE-3 vehicle, which was moved from a halo orbit, after several gravitational maneuvers in the moon's field, into a trajectory for a flight to the comet Giacobini-Zinner. Plans are being made for the end of the 1990s for carrying out similar missions to the same comet or to the comet Honda-Mrkos-Pajdusakova. A flight to the latter of the two comets is particularly enticing because the encounter point lies at a distance of just 0.18 AU from Earth, and at that time, two SSLs of the program for the Regata-Plazma project (Regata-V and Regata-S) should be in halo orbits. It will also be possible to launch a special SSL for a flight to the comet. We would note that the requirements for the SSL orbital insertion phase for a comet-intercept orbit and for the orbits of the Regata-V and -S SSLs are virtually identical.

Footnote

1. Regular readers of ZEMLYA I VSELENNAYA are familiar with the idea of using a solar sail during space flights (see, for example, the article by V. V. Radziyevskiy, "Light Pressure in the Solar System," ZEMLYA I VSELENNAYA, 1966, No 3—*Ed.*).

Nature of Relationship Between Streams of Electrons and Protons of Solar Cosmic Rays and Parameters of Microwave Bursts

917Q0121A Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 1, Jan-Feb 91 pp 95-103

[Article by V. F. Melnikov, T. S. Podstrigach, Ye. I. Daybog and V. G. Stolpovskiy]

[Abstract] A study was made of the relationship between flare-generated solar cosmic rays and the parameters of microwave bursts. The data were recorded with identical types of instruments on several the Prognoz-4 and -5 satellites and Venera probes in 1976-1978 and 1981-1983. The only events considered were those clearly identified with central and western flares and for which the proton flux exceeded 10^{-3} cm^{-2} x s^{-1} x sr^{-1}. It was found that the correlation between electron and proton streams and radio emission is considerably strengthened if the frequency of the spectral maximum and the effective duration are included in the radio index together with maximal burst intensity. It was demonstrated that the correlation between the stream of solar cosmic ray protons and the effective duration of a burst is greater than in the case of electron streams. That is attributable to the difference in the dynamics of the accelerated electrons and protons in flare loops of different sizes. The conditions for the escape of accelerated protons and electrons into interplanetary space were examined. The totality of these results can be used in a diagnosis of the total number of energetic protons in a loop and the conditions for their escape into interplanetary space on the basis of the radio emission of flares in the microwave and meter-decameter ranges. Figures 2; references 18: 10 Russian, 8 Western.

Evolution of Special Elliptical Orbits of Synchronous Artificial Earth Satellites

917Q0121B Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 1, Jan-Feb 91 pp 133-144

[Article by M. A. Vashkovyak]

UDC 629.015

[Abstract] A class of artificial Earth satellite orbits with an approximately 24-hour period of revolution is examined (inclination about 60°, eccentricity 0.5-0.8, and argument of perigee +90°). The described orbits, together with orbits proposed earlier, can be used in very long baseline interferometry. The principal perturbing factors for orbits of this class are lunar-solar attraction and noncentrality of the Earth's gravity field (in order of magnitude the two are approximately identical). The basis for this study of orbital evolution is the doubly averaged Hill problem with allowance for planetary oblateness. The zero approximation used is a particular solution of one of the integrable cases of this problem

when the orbital plane of the perturbing body coincides with the equatorial plane of the planet. The equations of motion, linearized in the neighborhood of this solution, are used in determining the dependence of the orbital elements of the artificial earth satellite on time, satisfactorily describing their change in a time interval of about five years with an accuracy to about 10-15 percent. The full derivation of the pertinent formulas is given. Figures 2; references 5: 4 Russian, 1 Western.

Influence of Geomagnetic Field on Periodic Motions of Satellite Relative to Center of Mass

917Q0121C Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 1, Jan-Feb 91 pp 145-148

[Article by I. M. Aksenenkova]

UDC 629.7

[Abstract] An analogy is drawn between the perturbed problem of a Lagrangian top in the case of small potential perturbations (which was examined earlier by the author in VESTN. MGU, No 1, pp 86-90, 1981) and the problem of rotation of a satellite whose center of mass moves in a circular orbit in the equatorial plane. Allowance is made for the influence of the Earth's magnetic field, which is modeled by a dipole field with an axis coinciding with the axis of the Earth's rotation. The role of perturbing factors in the latter problem is played by magnetization of the satellite shell and by the deflection of the satellite's intrinsic magnetic moment from the axis of the satellite's dynamic symmetry. A list is given of resonance tori of an unperturbed problem in whose vicinity are periodic solutions of the perturbed problem. The research is done on the basis of the Poincare theorem. References: 3 Russian.

Influence of Nonuniform Density of Charges on Spacecraft Surface

917Q0121D Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 1, Jan-Feb 91 pp 149-150

[Article by R. M. Zaydel]

UDC 66.085:621.315.61:537.521.7

[Abstract] Charges appear on a spacecraft surface as a result of the influx of charged particles from ambient space and the emission of photoelectrons knocked from the spacecraft surface by solar ultraviolet radiation. In studies of charge accumulation on a spacecraft surface, other researchers have assumed that the electrical field that is formed is directed along the normal to the spacecraft surface, that is, as if the surface were an equipotential surface. In this communication, the researcher demonstrates that with a nonuniform (over the spacecraft surface) emission of charged particles, a still stronger electrical field, parallel to the surface, may be formed. The problem is defined and the pertinent formulas for its solution are given in both approximate and precise forms. A numerical example is given for a case when the sun illuminates one hemisphere, while the other hemisphere remains in shadow. References 2: 1 Russian, 1 Western.

Propagation of Electromagnetic Fields From Seismic Sources Into Earth's Upper Ionosphere

917Q0120A Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 31 No 1, Jan-Feb 91 (manuscript received 25 Dec 89) pp 111-119

[Article by O. A. Molchanov, Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, USSR Academy of Sciences]

UDC 550.388.2:550.34

[Abstract] An attempt is made to clarify the mechanism underlying the recently discovered experimental effect of excitation of anomalous VLF radiation in the Earth's upper ionosphere over earthquake regions. According to the hypothesis, the radiation comes about as a result of interaction between ULF waves penetrating into the ionosphere and magnetosphere directly from earthquake foci and charged particles of circumterrestrial plasma. This article analyzes the propagation of the pulsed radiation of such a source through the Earth, atmosphere and ionosphere. A new model of the medium and source is used to show that electromagnetic energy can penetrate from a seismic source into the upper ionosphere and magnetosphere; the optimal frequency range is 0.3-10 Hz; the position of the intensity maximum is dependent on the source, Earth's conductivity and ionospheric parameters; a magnetic source is more effective than an electrical source for penetration into the upper ionosphere; electromagnetic energy penetrates into the magnetosphere in the mode of oblique Alfven waves; the zone of "irradiation" of the upper ionosphere by penetrating radiation has a circular configuration with a radius about 100-150 km. Figures 3; references 13: 9 Russian, 4 Western.

Thin Walls of Ionization Inhomogeneities in Polar Ionosphere Detectable by Satellite Radiofrequency Remote Sensing Method

917Q0120B Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 31 No 1, Jan-Feb 91 (manuscript received 27 Dec 89, after revision 19 Jun 90) pp 137-142

[Article by N. P. Danilkin, S. V. Zhuravlev, L. P. Morozova, V. I. Pogorelov and K. L. Tolskiy, Applied Geophysics Institute, USSR State Committee for Hydrometeorology and Environmental Monitoring]

[Abstract] Experimental data are given from rf remote sensing of irregular ionospheric inhomogeneities of a specific type ("walls") carried out from 5 May through

20 June 1987 from the Cosmos-1809 satellite, with ionograms recorded aboard the Sibir icebreaker moving along a Murmansk-North Pole-Dixon-Laptev Sea-Murmansk route. The ionograms display several series of typical scattering reflections not noted in earlier experiments, but similar to formations detected in Alouette-1 data. An example of such an ionogram is analyzed in detail (the time interval during which a satellite passes directly through the investigated plasma formation, or wall, is almost completely obscured on the ionograms by reflections from medium inhomogeneities close to the satellite, whose intensity increases sharply at the wall, making the interpretation difficult). The analysis made it possible to draw conclusions concerning the geometrical dimensions and internal structure of the inhomogeneities and indicatrix of backscattering of radio waves by the elements of the plasma forming the inhomogeneities. However, such formations may occur more frequently than observed because the geometry of the sensing used until now may not ensure their detection. Figures 3; references 5: 2 Russian, 3 Western.

Mechanisms of Stratification of Ionized Barium Clouds in Ionosphere

917Q0120C Moscow GEOMAGNETIZM I AERONOMIYA in Russian Vol 31 No 1, Jan-Feb 91 pp 143-149

[Article by Ye. M. Gokhman, V. B. Ivanov and S. A. Rudykh, Applied Physics Scientific Research Institute, Irkutsk State University]

UDC 550.388.2

[Abstract] A method was developed for investigating the linear stage of instabilities in the region of an artificial plasma formation. The method takes into account the nonlocal character of the process under study and the influence of the multicomponent nature of ion composition in the cloud-ionosphere system. Quantitative estimates were made of efficiency of gradient-drift instability in a cloud of ionized barium. With some optimal relations of the parameters of the background ionosphere and barium cloud, the maximum increment may attain 10^{-1} s^{-1}, which makes it possible to describe stratification processes from the standpoint of development of plasma instabilities. It is concluded that for a correct description of the conditions for the appearance of large-scale inhomogeneities of barium clouds it is necessary to analyze plasma instabilities on the basis of the nonlocal approach developed in this study. It was found that specific mechanisms for the development of plasma instabilities caused by the presence of transverse currents and gradients in plasma, jointly with nonuniformity of the ratio of mobilities of electrons and ions in a longitudinal direction, as well as the presence of different kinds of ions in the plasma, are effective for the generation of large-scale inhomogeneities. Estimates of the quantitative characteristics of the linear stage of instability make it possible to confirm the possibility of the generation of inhomogeneities as a result of the described mechanisms under real geoheliophysical conditions. Figures 4; references: 4 Russian.

Pearson Type VII Distribution of Errors of Laser Observations of Artificial Earth Satellites

917Q0147 Kiev KINEMATIKA I FIZIKA NEBESNYKH TEL in Russian Vol 7 No 3, May-Jun 91 pp 82-91

[Article by I. V. Dzhun, Rovno Scientific Research Institute for Machine Building Technology]

UDC 521.93:528.11

[Abstract] A study was made of the distribution of *O-C* (observed and computed) differences in ranges to artificial Earth satellites obtained when executing the brief MERIT program. It is shown that the difference in these differences is better described by a Pearson type VII curve than by the normal law. This can be attributed to fluctuations in the accuracy of observations caused by unstable metrological conditions. It is shown that the m parameter of the Pearson distribution varies from 2.7 to infinity (normal law). A special weighting function for a Pearson type VII distribution for processing observations is proposed, such that

$$p(x) = -y'/y\ (x^{-1}) = [(m-0.5/m)^3\sigma_{VII}{}^2 + x^2/2m]^{-1}$$

where y is the density law, σ_{VII} and m are the parameters for the Pearson type VII distribution, and x is the)-C difference. The main conclusion from the study is not that the classical methods for processing observations of satellites are not to be used, but that they are necessary as a preliminary processing stage only. The final processing of observations of satellites must include both a metrological and mathematical evaluation of the distribution of O-C differences. References 16: 12 Russian, 4 Western.

Observations of X-Ray Nova GS2023 + 338 by 'Rentgen' Observatory on 'Kvant' Module

917Q0148A Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 17 No 4, Apr 91 pp 291-309

[Article by R. A. Syunyayev, A. S. Kaniovskiy, V. V. Yefremov, V. A. Arefyev, K. N. Borozdin, M. R. Gilfanov, Ye. M. Churazov, A. V. Kuznetsov, A. S. Melioranskiy, N. S. Yamburenko, W. Pietsch, S. Doebereiner, J. Englhauser, C. Reppin, J. Truemper, W. Voges, E. Kendziorra, M. Maisack, B. Mony, R. Staubert, G. K. Skinner, M. R. Nottingham, H. Pan, A. P. Willmore, A. C. Brinkman, J. Heise, J. M. In't Zand and R. Jager, Space Research Institute, USSR Academy of Sciences, Moscow; Extraatmospheric Physics Institute, Max Planck Society, Garching, West Germany; Astronomical Institute, Tubingen University, West Germany;

Space Research Laboratory, Utrecht, Netherlands; Birmingham University, Great Britain]

UDC 520.6;524.352

[Abstract] The emission spectrum of the X-ray nova GS2023 + 338 was registered in the range 2-300 keV in June-August 1989 by instruments aboard the Rentgen observatory. The source position was determined within 25 arc seconds. During the observations, a decrease in X-ray luminosity characteristic of all X-ray novae was registered, as was a strong variability of the source. The hardness of the spectrum and the low-frequency noise that was recorded make it possible to classify the source as a black hole candidate. The spectrum recorded is one of the hardest ever recorded in the history of X-ray astronomy. Source location, X-ray spectrum, and luminosity, as well as variability of emission in the standard X-ray range and the nature of the soft component and the low-frequency noise in the power spectrum of the source, are discussed in detail and are compared with other data in the literature. Figures 9; references 31: 5 Russian, 26 Western.

X-Ray Images of Supernova 1987A Field. Observations With ART-P Telescope on 'Granat' Observatory in 1990

917Q0148B Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 17 No 4, Apr 91 (manuscript received 5 Oct 90) pp 310-320

[Article by S. A. Grebenev, R. A. Syunyayev, M. N. Pavlinskiy, I. A. Dekhanov, M. L. Markevich and N. S. Yamburenko, Space Research Institute, USSR Academy of Sciences, Moscow]

UDC 520.6;524.352

[Abstract] In 1990, the X-ray telescopes of the Granat observatory continued observations of the Supernova 1987A (SN 1987A) in the Large Magellanic Cloud that had been carried out in 1987-1989. The observations were made with the ART-P telescope with a coding aperture in the energy range 3-30 keV, making it possible to obtain a sky image in the X-ray range with a high angular resolution. The telescope was used in retrieving the image of a sector of the sky measuring 3.4 x 3.°.6 with an angular resolution about 5 arc minutes in the energy range 2.5-60 keV and in carrying out an analysis of the energy spectra of the detected sources. The ART-P telescope was pointed in the direction of SN 1987A twice: 23 May and 23 September 1990. The total time of observations was four hours in May and six hours in September. An upper limit 0.65 mCrab for the flux from SN 1987A was found to be in the range 3-15 keV. Only two other sources, LMC X-1 and PSR 0540-693, were found in the instrument field of view. Observational data on these three sources are given, analyzed and compared with other observations. Figures 4; references 26: 8 Russian, 18 Western.

Observations of Source 4U1700-37 in X-Ray Experiment on 'Prognoz-9' Artificial Earth Satellite

917Q0149 Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 17 No 5, May 91 (manuscript received 15 Oct 90) pp 410-418

[Article by M. I. Kudryavtsev and S. I. Svertilov, Nuclear Physics Scientific Research Institute, Moscow State University, Moscow]

UDC 520.6;524.35

[Abstract] In the course of an experiment on the Prognoz-9 satellite that lasted from November 1983 to January 1984, virtually continuous observations of the X-ray binary 4U1700-37 (its optical component is the blue giant HD153919 of the spectral class 07) were made for 73 days. The satellite carried instrumentation for measuring the fluxes of X-radiation, as well as charged particles responsible for the formation of different components of the instrument background in the X-ray instrument. The principal instrument was a scintillation spectrometer based on a CsI(Tl) crystal with an effective area of about 40 cm^2, which made it possible to register fluxes in the energy range 10-200 keV. The field of view of about 0.7 sr was bounded by an azimuthally isotropic collimator in such a way that the maximal angle of incidence of the registered photons was about 50° from the detector axis. Mean light curves with a time resolution two hours were obtained in the energy ranges 10-50, 25-50 and 50-100 keV. The eclipse duration, determined from the mean light curves in the energy range 10-50 keV, was about 12 hours (about 0.14 of the total phase). The phase dependencies of the parameters characterizing the spectral hardness of system emission provide evidence that the shape of its spectrum remains constant. Figures 2; references 24: 4 Russian, 20 Western.

Minimax Property of Discrete Kalman Filter With Inexactly Stipulated Dispersion Matrices

917Q0154A Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 2, Mar-Apr 91 pp 194-200

[Article by A. I. Rusakov and I. K. Kokhanenko]

UDC 62.50

[Abstract] In the algorithm for a discrete Kalman filter, the distinction between the nominal dispersion matrices used and the true matrices results in a worsening of the accuracy in evaluating the vector of state. It is shown that in a case when the true dispersion matrices are majorized by known matrices, the use of the latter for filtering ensures the best guaranteed value of the square quality criterion. An equation is derived for determining the measure of the decrease in the error criterion of the evaluation by using guaranteed dispersion matrices. The results of computations for identifying the parameters of

motion of an artificial Earth satellite in a near-circular orbit are presented. The researchers point out that the difference in the standard deviation of error in determining radial velocity from the minimal possible error is less than 10 percent in the interval 150-250 s of a measurement session; for the longitudinal velocity component it is less than 10 percent in the interval 80-120 s. On the other hand, at the beginning of a session, and also for a quite long observation (about 500 s), the filtering results have little dependence on the choice of the dispersion matrix of the initial state. Figures 1; references 5 (Russian).

Mechanism Underlying Rotation of Satellite Orbital Plane

917Q0154B Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 2, Mar-Apr 91 pp 201-211

[Article by Yu. G. Markov and I. S. Minyayev]

UDC 629.7

[Abstract] The orbital planes of motion of natural satellites formed outside the equatorial plane of a planet, slowly evolve in the direction of that plane under the influence of tidal forces. The researchers here assume that a material point (natural satellite) moves in the field of attraction of a dynamically symmetric planet, and the satellite's orbit is inclined at an arbitrary angle to the equatorial plane of the planet. Emphasis is placed on the study of one of the factors exerting an influence on evolution of inclination of a satellite orbit if the planet contains a mass of a uniform viscoelastic medium (Kelvin-Voigt material) and dissipation of energy occurs as a result of internal friction forces in the material. Since tidal deformations carry off energy during motion of the system (planet-satellite), the system tends to change from almost all initial conditions to stationary configurations corresponding to a minimum of the total energy. The researchers study the mechanism underlying the slow change in the inclination of the orbital plane of a satellite that results from the work of internal dissipative forces on the part of the planet being deformed. It is shown that in the case of a nonrotating planet, a change in inclination of the orbital plane may occur both toward the equator of the planet or in the opposite direction. Depending on the elastic properties of the body, there also may be intermediate stationary positions of the orbital plane. Planetary rotation exerts an influence on inclination of the satellite orbit, and as a result of the evolutionary process, it then coincides with the equatorial plane of the planet. In the case of a rapid planetary rotation, the inclination of the orbital plane decreases monotonically. Figures 2; references 6 (Russian).

Optimal Spatial Turn of Space Vehicle With Variable Geometry of Masses

917Q0154C Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 2, Mar-Apr 91 pp 221-230

[Article by V. I. Gulyayev, V. L. Koshkin and I. V. Savilova]

UDC 62.102.12

[Abstract] The problem of optimal control of the spatial reorientation of a gravitationally stabilized space vehicle is examined in the context of speed of control. Attitude control is effected by means of reactive torque produced by low-thrust engines with simultaneous programmed change in the length of gravitational stabilizers, which are rigid rods with masses on the ends. The study looks at the joint use of two attitude-control systems. An analysis of the characteristics of optimal reorientation modes was made as a function of gravitational and controlling moments. It was established that in the case of a small duration of turning, the moments of inertial forces considerably exceed the gravitational moments, and therefore the influence of the latter can be disregarded. With an increase in body turn time, the moments of inertial forces decrease, and the influence of gravitational moments becomes substantial. It is shown that with small controlling moments, the influence of the gravity field is manifested in an increase in time of the reorientation maneuver. The best control programs in that case differ from programs formulated without allowances for the fields in number of switch-ons and presence of sectors of special control. Figures 4; references 8 (Russian).

Generalized Characteristics of Gyro Control Systems

917Q0154D Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 2, Mar-Apr 91 pp 231-237

[Article by V. N. Vasilyev, D. M. Veynberg and S. I. Zlochevskiy]

UDC 629.78

[Abstract] Four generalized characteristics are proposed for evaluating the controlling capabilities of gyro control systems: region of change of the kinetic moment vector, region of change of the controlling moment vector, standard moment characteristics, and isochronal surfaces of kinetic moments. It is assumed that the gyrosystem consists of n identical gydrodynes with two degrees of freedom. It is shown that the four generalized characteristics provide a complete, graphic idea concerning the controlling properties of the gyro control system. All the generalized characteristics or individual characteristics most suitable for solution of the formulated problem can be used in an analysis of specific

gyrosystems and algorithms for gyrodyne control. The S region defined in this study determines the potential capabilities of a gyrosystem with respect to change in the kinetic moment vector. The W region, which also is defined, characterizes the potential capabilities of the gyrosystem with respect to change in the controlling moment vector at a stipulated point. The moment characteristics determine the change in extent of the W region during motion of a representative point along standard trajectories. A family of isochronal kinetic moment surfaces gives some idea concerning the controlling properties of the gyro control system for an entire ensemble of standard trajectories. The generalized characteristics can be used in determining the effectiveness of algorithms for control of gyrodynamics and for a comparative analysis of different gyrosystems. Figures 4; references 8 (Russian).

Navigation Based on Relative Measurements on Approach Segment to Mars

917Q0154E Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 2, Mar-Apr 91 pp 247-254

[Article by N. M. Ivanov and P. R. Ivankov]

UDC 629.78

[Abstract] A highly precise navigation method is proposed for use on the approach segment to Mars. The essence of the proposed method is as follows. Two coupled vehicles approach the planet. Prior to entry into the atmosphere, they separate, and a momentum is imparted to one of them. Measurements of the components of apparent acceleration are made with accelerometers. Then relative range and radial velocity are measured. Since the values of these parameters are dependent on the coordinates and velocities of the objects, measurements of relative range and radial velocity make it possible to solve the navigation problem. Although the parameters of motion of the vehicles could be determined without apparent acceleration measurements, the use of accelerometers provides additional information on the nongravitational forces acting on the vehicles. This information increases the accuracy in solving the navigation problem and makes it possible to compensate for systematic errors in measuring relative range and radial velocity. The method makes it possible to determine the parameters of longitudinal motion of a spacecraft on the approach to Mars. The results of numerical simulation revealed a high efficiency of the proposed algorithm. The method can be used for ensuring entry of a spacecraft into a Martian orbit with use of aerodynamic braking. Figures 4; references 3 (Russian).

Optimal Launch of Artificial Earth Satellite With Use of Aerodynamic Lift

917Q0154F Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 2, Mar-Apr 91 pp 255-271

[Article by A. S. Filatyev, Central Aerohydrodynamic Institute]

UDC 521.1

[Abstract] A study was made of the problem of optimization of the trajectories of a space vehicle put into an artificial Earth satellite orbit with the use of aerodynamic lift. A numerical optimization procedure is described which is based on the Pontyagin maximum principle, which ensures good convergence and high speed. The developed procedure includes solution of a corresponding two-point boundary value problem by the modified Newton method with automatic choice of the initial approximation with a solution by the continuation method and with the selection of local extreme solutions. Rather complete models of trajectory motion of a spacecraft were used in investigating qualitative restructuring conditions—including bifurcation of type, optimal launch conditions, optimal control programs, and optimal trajectories for putting a spacecraft into orbit—governed by the influence of aerodynamic forces. The results indicate that the influence of aerodynamic forces that are small in comparison with thrust determines the structure of optimal trajectories and laws of spacecraft control during the stage of injection in the dense layers of the atmosphere. Figures 9; references 17: 16 Russian, 1 Western.

Three-Dimensional Model of Hydrogen Cloud in Upper Atmosphere With Allowance for Chemical Interaction

917Q0154G Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 2, Mar-Apr 91 pp 272-277

[Article by M. N. Vlasov and Ye. G. Slekenichs]

UDC 551.510.53

[Abstract] A three-dimensional diffusion model of a cloud of hydrogen injected into the upper atmosphere and the results of model computations for differe nt altitudes and injected masses are presented. The results of simulation of the dynamics of a hydrogen cloud in the upper atmosphere are given. Diffusion processes are found to play the main role in cloud dynamics, at least as long as the hydrogen concentration remains substantial. The principal features of hydrogen distribution are formed under the influence primarily of diffusion in the gravity field: a decrease in the altitude of the concentration maximum at the center of the cloud and its increase at the edges and transition from an initial spherical to a final ellipsoidal configuration. While chemical reactions

exert no appreciable influence on cloud dynamics, they change considerably the distribution of charged particles in the region of the main ionospheric maximum, resulting in formation of an "ionospheric hole." The dropoff of electron concentration may attain an order of magnitude or more and the configuration of the "ionospheric hole" becomes pear-shaped. However, it is difficult to use the diffusion approximation for describing the dynamics of a hydrogen cloud of an extremely large mass (tens of kilograms) because in the process of quite rapid expansion, a considerable fraction of the hydrogen reaches an altitude where the length of the free path becomes comparable to, and then exceeds, the scale of atmospheric heights. Figures 3; references 5: 2 Russian, 3 Western.

Generation of Accelerated Plasma Electrons and Measurement of Spacecraft Electrical Potential in Ionospheric Experiments With Injection of Electron Beams

917Q0154H Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 2, Mar-Apr 91 pp 278-281

[A. Yu. Bogomolov and V. A. Fedorov, Radio Engineering Institute imeni Academician A. L. Mints, USSR Academy of Sciences]

UDC 533.95:551.510.535

[Abstract] The magnitude of spacecraft electrical potential and the nature of its variation have a decisive influence on the physical processes that take place in the ionospheric plasma that envelops the spacecraft and are among the chief factors that form the structure of an injected electron beam. The researchers here studied the influence of accelerated plasma electrons on potential measurements and found that the accelerated electrons may exert a substantial influence on the readings of instruments used in measuring electrical potential and that there is a detuning band where that can happen. Accordingly, in measuring the electrical potential of a spacecraft by measuring the energy of plasma electrons forming the neutralization current of a spacecraft charge, it is necessary to know the dependence $\varepsilon = \varepsilon(t)$. If ε falls in the band $\varepsilon_{min}<\varepsilon<\varepsilon_{max}$, where the generation of accelerated electrons is possible, accelerated electrons must be excluded from among the recorded particles when measuring the current and energy of plasma electrons. References 14: 11 Russian, 3 Western.

Nonadiabatic Theory of Motion of Charged Particles in Geomagnetic Dipole Field

917Q0154I Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 2, Mar-Apr 91 pp 282-288

[Article by I. V. Amirkhanov, A. N. Ilina, V. D. Ilin and B. Yu. Yushkov]

UDC 524.629.78

[Abstract] A nonadiabatic model of motion of particles in a dipole field is examined. A full solution of the problem is possible only with a numerical experiment which embodies analytical and numerical methods. That applies, in particular, to the high-energy component of the radiation belts, for which the drift approximation is not applicable and the Stormer method gives only a partial analytical solution. Such an experiment was carried out in order to find a rather simple (similar to the drift theory) analytical description of the behavior of particles in a broad range of energies in space traps of the dipole type. The experiment is based on such key concepts as orbital magnetic moment, leading line of force, and loss cone. On that basis, a new model is proposed that enables short-range predictions of nonadiabatic dynamics of particles (approximately during one period of longitudinal oscillations). The proposed model is quite rigorous for equatorial pitch angles equal to or less than 50°. The range of pitch angles 50° requires additional special numerical research. Figures 5; references 9 (Russian).

Inverse Thermal Sounding Problem. 3. Retrieval of Vertical Profile of Mixing Ratio of Trace Gas Component

917Q0154J Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 2, Mar-Apr 91 pp 289-297

[Article by Ye. A. Ustinov]

UDC 535.24:523.42

[Abstract] The third report in a series (for earlier reports, see KOSMICH. ISSLED., 1990, Vol 28 No 3, pp 402-412; ibid., No 5, pp 725-736, 1990), this report applies an inverse problem formulated earlier to the sounding of a trace gas component in its absorption band in a planetary atmosphere. It is shown that the application of this inverse problem in the interpretation of real observations of trace gas components in absorption bands having a rotational structure obviously requires line-by-line computations in each iteration. In essence, such computations are necessary in a model approach (in selecting the models best reproducing measurement results). The program or subprogram for computing the weighting functions can be formulated by modifying the program for computing the gas transmission functions. Its structure and work in the stage of computation of the monochromatic transmission coefficients remain unchanged. Spectrophotometric data on outgoing thermal radiation of planetary atmospheres probably constitute a broad field of applicability of the inverse problem formulated here. The results of their interpretation can be used as a first approximation. An evaluation of the retrieval error as a function of altitude, obtained jointly with solution of the inverse problem and naturally taking the error in measurement data into account, will make it possible to evaluate the limits of

applicability of the resulting solution. The weighting functions and the integral sensitivities constitute significant additional information which will make it possible to evaluate the sensitivity of the measurement data to the sounded profile of the atmospheric mixing ratio. Figures 4; references 18: 7 Russian, 11 Western.

Choosing Body Shapes With Minimal Aerodynamic Heating During Motion in Atmospheres of Solar System Planets

917Q0154K Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 2, Mar-Apr 91 (manuscript received 10 Jan 90) pp 298-309

[Article by M. A. Korchagina and N. N. Pilyugin]

UDC 629.785

[Abstract] In order to formulate the variational problem of determining the configuration of an axisymmetric or plane body in the context of minimal total convective and radiative heating of a body along the trajectory of motion in a planetary atmosphere, it is necessary to have expressions for the total heat flows to these bodies and the wave resistance and friction coefficients. Those expressions, basic for further analysis, are derived. The functional of the variational problem is constructed by joint integration of the equation of motion for a body moving in a planetary atmosphere at a great supersonic velocity and an equation describing heating of a vehicle along the entire trajectory of its motion is derived. The change in configuration of a body due to the destruction of the heat-shielding covering is disregarded. For the first time, functionals are obtained for plane bodies, which is important because wings have recently come into use for reentry modules. Computations of total heating and drag of blunted cones during motion in the atmospheres of the Earth, Venus and Jupiter are cited. Possible ways to simplify variational problems are defined on the basis of an analysis of those computations. Figures 2; references 20: 17 Russian, 3 Western.

Methods for Determining Unfavorable Illumination Intervals of Spacecraft Optoelectronic Instruments

917Q0154L Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 2, Mar-Apr 91 pp 310-317

[Article by D. I. Ibragimov]

UDC 539.165

[Abstract] This is essentially a continuation of an earlier study by I. D. Ibragimov, *et al.* ("Determination of Intervals and Dates of Onset of Critical Illumination Conditions for Spacecraft Instruments," KOSMICH. ISSLED., Vol 25, No 1, 1987). Continuing the line of research, a study was made of the problem of determining unfavorable intervals of illumination of spacecraft optoelectronic instruments. In solving the problem, the osculating elements of the spacecraft orbit are considered to be known: semimajor axis, eccentricity, inclination of the orbital plane to the equatorial plane, angular distance of perigee from the ascending node, longitude of the ascending node and solar position. In solving such problems, the unfavorable illumination conditions are expressed in the form of vectorial inequalities and are transformed to simple trigonometric or algebraic inequalities. The resulting inequalities allow analytical, semianalytical or approximate solutions as a function of the class of orbits and the form of illumination. Figures 3; references 5 (Russian).

Search for Optical Flares From Gamma-Ray Barsters as Observed by Meteor Patrols and Wide-Angle Cameras

927Q0009A Moscow ASTRONOMICHESKIY ZHURNAL in Russian No 3, May-Jun 91 pp 522-528

[Article by A. N. Karnashov, Ye. I. Moskalenko, Ye. N. Kramer, I. S. Shestaka, L. M. Sherbaum, S. V. Nazarenko, Yu. M. Gorbanev, V. F. Lemeshchenko, S. V. Podlesnyak, L. Ya. Skoblikova, A. K. Markina, V. I. Musiy and Yu. G. Taranukha, State Astronomical Institute imeni P. K. Shternberg; Astronomical Observatory, Odessa State University; Astronomical Observatory, Kiev State University]

UDC 523.84.035.922.2

[Abstract] The results of a search for flare optical radiation from gamma burst sources are presented. The search was carried out using collections of negatives registered by the meteor patrol at Odessa Astronomical Observatory (OAO) (750 hours, 420 hours synchronously with two base instruments), meteor patrol at Kiev Observatory (5400 hours, 4020 hours with a minimum of two instruments), MK-75 cameras at the OAO (total record 470 hours) and all-sky cameras at the OAO (total observation time 260 hours). Data processing procedures are fully described. Data analysis revealed that at the sensitivity level $5\text{-}7^{m}$ with a duration more than 1 s no flares of astrophysical origin were discovered, giving an upper limit 6.5×10^{-4} hour^{-1} x sr^{-1} for the frequency of such events with a 95 percent confidence coefficient. A serious factor which must be taken into account is the possibility of the appearance of a blinking satellite or aircraft in the instrument field of view. It is estimated that approximately one such event will occur in the course of 1000 hours of observations with an instrument with a field of view 3° and a brightness flare of 6^{m} will look like a star with approximately $11\text{-}13^{m}$. Figures 3; references 20: 6 Russian, 14 Western.

Comet Flight Through Magnetosphere of Neutron Star: Possible Cause of Space Gamma-Ray Bursts

927Q0009B Moscow ASTRONOMICHESKIY ZHURNAL in Russian No 3, May-Jun 91 pp 590-601

[Article by I. G. Mitrofanov and R. Z. Sagdeyev, Space Research Institute, USSR Academy of Sciences]

UDC 524.35.6

[Abstract] All the principal models of generation of cosmic gamma-ray bursts associated with neutron stars are fraught with serious difficulties and alternative models are therefore being sought. It is shown that the magnetodipole radiation of neutron stars rotating with periods > 100 ms cannot evaporate a comet passing by at a distance of about the radius of the light cylinder. As a result, a comet within the cylinder may enter into a region of the static rotating magnetosphere and in it, causing "short circuiting" of the external vacuum gap, may excite powerful global currents. It is shown on the basis of a physical model of quiescent radio pulsars that at the time of a comet flyby cosmic gamma-ray bursts may be generated in the magnetosphere of the neutron star. Allowing applicability of known models of Oort's circumsolar cloud to the distribution of comets in the interstellar medium, estimates were obtained for the mean time between flights of comets through the magnetospheres of neutron stars. It is shown that they are consistent with known estimates of the time of activation of sources of "classical" gamma-ray bursts. It is proposed that the activity of sources of repeated bursts be attributed to a substantial decrease in recurrence time during passage of a neutron star through a circumstellar cometary cloud of the Oort's Cloud type. It was established that the new model of Oort's Cloud proposed on the basis of observations of Halley's comet is quite consistent with observational data on repeated bursts. [Basic materials along these lines were published by the authors in NATURE, Vol 344, p 313, 1990.] References 32: 6 Russian, 26 Western.

Atmospheric Quality of Astronomical Image at Some Points in USSR

927Q0009C Moscow ASTRONOMICHESKIY ZHURNAL in Russian No 3, May-Jun 91 pp 632- 638

[Article by P. V. Shcheglov and A. E. Guryanov; State Astronomical Institute imeni P. K. Shternberg; Atmospheric Physics Institute, USSR Academy of Sciences]

UDC 520.16

[Abstract] Measurements of Polaris image motion (1977-1987) were made at 10 sites in the USSR, including observatories in the Crimea, in the Caucasus and Central Asia, for determining quality of the astronomical image. The instruments suitable for evaluating the atmospheric quality of astronomical images are discussed. The measurements were made using the FEP portable photoelectric instrument with an objective diameter 3.5 or 5 cm. The most favorable statistics for atmospheric quality of the image were obtained for Mount Sanglok in Tajikstan. The statistics were better than for Mount Maydanak in Uzbekistan and in comparison with the best among the investigated points abroad are inferior only to Mauna Kea observatory in the Hawaiian Islands. Two tables give pertinent data for Soviet and foreign observatories. The tables published earlier by other authors containing evaluations of the quality of astronomical images at a number of places in the USSR were obtained primarily as a result of visual observations not meeting all the conditions outlined in this article and therefore are inadequate. In seeking a new site for an observatory in the USSR with possibilities for obtaining a quality of the optical image as good as the best foreign observatories a site must be sought with conditions closer to those of Sanglok than to Maydanak. Figures 2: references 30: 17 Russian, 13 Western.

Utility of Lunar Bases for Resource Exploitation

917Q0178 Moscow DELOVOY MIR in Russian No 173-174, 3 Aug 91 p 5

[Interview with Vladislav Vladimirovich Shevchenko, doctor of sciences and head of the Department of Lunar and Planetary Study of the State Astronomy Institute imeni Shternberg at Moscow State University, by DELOVOY MIR special correspondent Svetlana Omelchenko, candidate cosmonaut from the USSR Union of Journalists: "For Iron...to the Moon"; first paragraph is DELOVOY MIR introduction; italicized text is Omelchenko's commentary]

[Text] **Viktor Nikolayevich Samotoylov, a specialist of the Cosmonaut Training Center, acquainted us with Doctor of Sciences Vladislav Vladimirovich Shevchenko, head of the Department of Lunar and Planetary Study of the State Astronomy Institute imeni Shternberg at Moscow State University. And he did not just acquaint us with him, but gave up a few of the hours allotted by the program of general space training to the study of astrophysical experiments.**

The theme of our conversation is extraterrestrial natural resources.

Omelchenko: We know that mineral prospecting is successfully conducted with the enlistment of aircraft and space hardware. But should we turn our eyes toward other planets? Is that not too daring? Where does such an idea come from?

Shevchenko: Traditional energy sources are running out. The problem will loom before the next few generations with extreme urgency. You and I are already suffering from an oversaturation of the Earth's atmosphere with harmful waste products and excess heat. That is a result of the burning of coal, petroleum, and gas and, to some extent, the use of nuclear power. There is no need to say what consequences that is leading to. That is why scientists have directed their attention to resources beyond our planet.

Omelchenko: But what do we know about the other bodies in the solar system?

Shevchenko: Quite a bit. The planets of the Earth group—Mercury, Venus, and Mars—have been studied the most. They are closer, and their natural conditions are comparable to ours. Mercury turns out to be similar to the Moon, but it has a large iron core. The radio probing of Venus and other methods that have been used to study it have made it possible to establish that it is a very active body, with a temperature of 400-500°, a pressure at the surface of about 100 atmospheres, and active volcanic processes. The average temperature of Mars is about 40°,and Mars also has an atmosphere, whose its density, it is true, is low, like Earth's atmosphere at an altitude of 30 km. Traces of water have been detected on the surface, and, perhaps, it exists as ice. The Moon, as we assumed, is a dead body that came to a halt in its development approximately 2 million years ago.

All those celestial bodies have a hard-rock core. The information about Pluto is vague, it was also discovered much later. We know that the structure of the giant planets is gaseous, and their core is dense. Jupiter, for example, can be thought of as an unborn star—its gas composition is similar to the composition of stars, but there is not enough mass, and there are no nuclear reactions.

Omelchenko: Assume that science will extend even more our notions about the other planets, and assume even that it will make it possible to detect on them the resources needed by earthlings. But how are we to exploit those resources? After all, even an expedition of specialists to our closest neighbor, Mars, is the problem of problems for the next few decades, and performing such a mission will be possible only through the efforts of many developed countries.

Shevchenko: In my opinion, a mission to Mars—it's more a demonstration of the achievements of science, technology, and human genius, whereas the development of lunar reserves promises an altogether real return. John Young, an American astronaut and a participant in two lunar missions, also believes that the development of the Moon is more practical than a Mars mission, although, as deputy general director of NASA, appointed to that position after the Challenger disaster, he is worried at this point about the safety of a flight to Mars.

Omelchenko: But what can you say about the Moon, except that it is a "dead body"?

Shevchenko: According to rough estimates, from a section of the lunar surface measuring 100 X 100 meters and with a depth of 10 meters it is possible to obtain 40,000 tons of silicon for the construction of solar arrays, 30,000 tons of aluminum, 25,000 tons of iron, and 9,000 tons of titanium. It is possible to recover from the same plot up to 80,000 tons of oxygen, which occurs in an oxidized state and can be extracted by being heated to 600-700° Celsius. A small mirror and a solar collector will make it possible to produce temperatures of up to 1,000°.

The products of solar wind, helium and hydrogen have, over the course of 4.5 billion years, saturated the surface of the Moon. From that same area, it is possible to obtain from 10-100 tons of hydrogen.

By recovering hydrogen (and there is about 0.05 gram of it in every gram of lunar substance), oxygen, and water, it is possible to solve the problem of refueling space rockets, that is, the problem of delivering mineral resources from lunar bases to Earth.

Omelchenko: Are lunar bases a matter of the distant future or of our times?

Shevchenko: The Johnson Space Center first advanced the idea of lunar bases. The first symposium devoted to the discussion of the problem of building lunar bases was held back in 1984, the second was held in 1987. About 500 scientists took part in it, and about 300 papers were read. I spoke on behalf of our country. The report was titled "The Soviet View of the Lunar Problem." In all honesty, I should say that it was my personal view. There simply was no Soviet view.

Today, the designs of lunar bases actually exist, in mockups and drawings for the time being. They consist of modular structures. Power from solar arrays is expected to be used in the future, but initially power from a nuclear source will be used. (V. Shevchenko shows slides with mockups of lunar bases. They consist of small modular structures, within which there are both factories and living quarters.)

The first mission [Vladislav Vladimirovich continues] will deliver the first structures by the Shuttle to the Freedom, and from there by lunar craft to our satellite [the Moon]; they will be unfolded automatically. The optimum crew composition of the mission has been determined to be six people.

Omelchenko: You speak about fantastic things so confidently that it is difficult to refrain from the question: "When?"

Shevchenko: The U.S. government has promised to appropirate money for design development starting next year. A plant for the recovery of lunar soil is expected to be built in 2020.

I am trying to estimate how old we will be in 2020. No, they won't take any of us to the Moon, if only because of age. But, perhaps, we will still succeed in writing about the construction and operation of the first lunar base. Although hardly any of the graduates of our Cosmonaut Training Center will come to be on that mission. The project is an American one, anyway.

True, it is that sad circumstance that forces one to believe in its practicability. After all, how many of our, domestic, projects—from the building of communism to the solution of the food problem—simply remained on paper.

Our space program also has advantages that, for the present, are indisputable. The experience gained from the lengthy stays of specialists on space missions is worth something. The Americans don't have that experience. It will certainly be needed both for work on the Freedom and for the maintenance of lunar bases. Perhaps, we will still succeed in combining efforts.

And now Shevchenko is talking about the search for asteroids that are suitable for our terrestrial purposes by a network of telescopes and about a highly sensitive facility that was recently put into operation.

Shevchenko: Five years ago, it was suggested that we could encounter most of the asteroids—including quite small ones less than 1 km in diameter—somewhere beyond Mars, but systematic observations have already revealed several celestial bodies in an almost dangerous proximity, between Earth and the Moon, rushing along at a velocity of 15-20 km per second.

The first thing we have to do is to detect such bodies. Later on, the problem of their transportation to near Earth orbit for subsequent processing will have to be solved. Perhaps, vehicles that are propelled by solar wind will prove to be extremely useful here. The solar sail idea has ardent supporters.

The possibility that the need may arise not only to capture, but also to repel some asteroid is also not ruled out....

We were returning in the evening from Zvezdnoye to Moscow. In a traffic jam on the Shchelkovo Highway one of us suddenly said:

"Remember what silly songs there used to be: 'Do you want to go to the Moon?—Yes!—Do you want a million?—No!' In fact, now I want to go to the Moon, too, and I wouldn't reject a million, either. But what would you do with that 1 million?..."

The pursuit of first-places and records for purely political purposes seems senseless, when problems common to mankind have to be solved. The first artificial Earth satellite, the flight of Yu. Gagarin, the spacewalk of A. Leonov, just as the first steps on the Moon, belong to all mankind. Maintaining one's preeminence in space comes through increasingly greater effort. The cutback of monies for space research is being attributed to the dissatisfaction of our citizens with the spending on space. But is that dissatisfaction really directed at space research? It's more likely directed at the senseless spending of money with no regard for real economic laws or for the clear-cut, sound prospects of space or the development of agriculture or land reclamation. If economic laws begin to work in all spheres of life, we will find millions, which in the future will save us hundreds and thousands times more—both in money and in the beauty of Earth, its tranquility, and its safety.

Plotting of Reflectivity and Roughness Maps of Venusian Surface

917Q0114 Moscow GEODEZIYA I KARTOGRAFIYA in Russian No 1, Jan 91 pp 49-54

[Article by A. V. Abramov, A. V. Grechishchev, N. V. Zherikhin, I. A. Zheltikov, G. M. Levchenko and A. A. Morozov]

UDC 528.93:523.42

[Abstract] Special maps were produced at the Moscow Power Engineering Institute depicting information on the reflectivity and roughness of the Venusian surface; the information was recorded in the radio range. These

data make it possible to judge the morphology of extensive surface areas and its electrophysical properties. The method for compiling such maps is examined, and the maps are briefly analyzed. The authors developed and used a variant of computations in which the desired parameters are determined from a comparison of automatic volume control (AVC) systems for the SLR (side-looking radar) and RA (radioaltimeter) channels of the Venera-15 and Venera-16 interplanetary stations. So-called AVC maps were constructed separately using data from the RA and SLR channels. Formulas are proposed for computing the Venusian coordinates. The AVC maps were plotted in a normal stereographic projection. These maps served as a base for compiling roughness and reflectivity maps, the procedures for which are described. The plotted maps made it possible to determine surface slopes for the northern regions of Venus. It appears that the Venusian surface on the average is far more even than the Earth's surface, although extreme elevations for the two planets are comparable. The maps reveal that there is no unambiguous dependence between elevation and the reflection coefficient or surface roughness. Figures 4.

Asteroid Surface Matter

917Q0115A Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 25 No 1, Jan-Feb 91 pp 5-26

[Article by D. F. Lupishko and I. N. Belskaya, Astronomical Observatory, Kharkov State University imeni A. M. Gorkiy]

UDC 523.44

[Abstract] This review is based on research results published, for the most part, during the last three years and reflects the modern point of view concerning the mineralogical composition of asteroids. The reviewers examine the initial observational data for studying the composition of asteroids, the mechanisms of formation of absorption spectra, spectral characteristics of the principal mineral phases, taxonomic classes of asteroids, and their general mineralogical characteristics. The nature of the matter in C (and other low-albedo types), S, and M asteroids is systematically covered, followed by an examination of 4 Vesta. The evolution of the dominant type of matter with heliocentric distance, including the the most probable heating mechanism governing the early thermal evolution of the asteroids, is discussed. CCD spectrophotometry, polarimetry, photometry, radiometry and radar observations have recently been added to laboratory research and traditional spectrophotometry for studying the composition of the surface materials of asteroids. It is hoped that the totality of these methods will enable progress in such directions as an estimate of the content of metal in the surface matter of asteroids, identification of differentiated compositions, and determination of the parent bodies of ordinary chondrites and other meteorites. This will make possible a fuller understanding of the evolutionary history of the asteroid belt and give hints as to its future. Figures 9; references 51: 4 Russian, 47 Western.

Lunar Gravity Field and Some Lunar Surface Characteristics

917Q0115B Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 25 No 1, Jan-Feb 91 pp 27-33

[Article by L. A. Savrov and Ye. K. Kuchik, State Astronomical Institute imeni P. K. Shternberg]

UDC 523.3-336

[Abstract] An attempt was made to determine the interrelationship between the lunar gravity field and certain of its surface physical characteristics: albedo, degree of polarization, and crater distribution density. All four types of initial data were represented by isoline maps based on a digital grid of values corresponding to the centers of 10° map frames. The maps of gravity anomalies and crater distribution density cover the entire lunar surface, whereas the maps of albedo and degree of polarization were plotted for the visible hemisphere. (Figure 1, for example, shows an albedo map constructed in an equal-area pseudocylindrical Mollweide projection). Correlations were investigated along profiles along the parallels and meridians passing through the centers of map frames. This involved first the plotting of 72 curves of the distributions of gravity anomalies, albedo, polarization, and density of craters as a function of longitude, with fixed latitudes of the centers of the map frames, and then 144 curves of the distribution of these same characteristics as a function of latitude, with fixed longitudes of the centers of the map frames. Profiles of characteristics were constructed along parallels and meridians passing through the centers of the largest lunar mascons. The harmonic and profile analyses which were made failed to reveal an explicit positive correlation between the lunar anomalous gravity field and its considered surface characteristics. Figures 6; references 6: 5 Russian, 1 Western.

Determining Chemical Composition of Lunar Surface From Joint Gamma-Ray, X-Ray and Optical Remote Measurements

917Q0115C Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 25 No 1, Jan-Feb 91 pp 34-44

[Article by N. N. Yevsyukov, Yu. A. Surkov and E. I. Chumak, Kharkov State University; Geochemistry and Analytical Chemistry Institute imeni V. I. Vernadskiy, USSR Academy of Sciences]

UDC 523.3:550.4

[Abstract] Materials are presented showing that a joint X-ray, optical and gamma-ray survey makes it possible to map the chemical composition of the lunar surface with respect to all its principal components. A shortcoming of the method is that it is indirect rather than

direct and is based on averaged dependences of the optical and chemical parameters of rocks and also averaged percentages of the chemical components. Accordingly, it is impossible to detect deviations of the real composition from the mean dependences. The strongest merit of the method is its ability to plot the distribution of chemical composition of the lunar surface with a spatial resolution accessible to optical systems and with a reliability typical of gamma- and X-ray measurements The proposed method is entirely feasible, although its use requires considerable additional research. Figures 5; references 15: 12 Russian, 3 Western.

Possibility of Space X-Ray Diffractometry

917Q0115D Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 25 No 1, Jan-Feb 91 pp 61-64

[Article by V. G. Feklichev and U. B. Khangildin, Mineralogy, Geochemistry and Crystal Chemistry of Rare Elements Institute, USSR Academy of Sciences; Space Research Institute, USSR Academy of Sciences]

UDC 523.0:549.0

[Abstract] It is proposed that X-ray powder diffractometry be used (supplementing IR spectroscopy) for remote analysis of the mineralogical composition of space bodies. Such an analysis could be made using unmanned vehicles, with telemetric transmission of the processed results to the Earth. X-ray diffraction spectra have a high information content because they reveal a great many narrow lines; 20 very strong lines of the X-ray diffraction spectrum are adequate for distinguishing one mineral from another in a set of 200-300 phases. Very little matter is required for obtaining diffractograms. A number of new methods have appeared for the registry of X-ray powder diffraction spectra which are more suitable for automation than those in common use. It is proposed that a compact, low-weight, automatic space instrument could be developed by combining a cylindrical Debye chamber and the principle of multichannel detection of the X-ray diffraction spectrum using a sample with a volume of only 1 mm^3. An on-board minicomputer or special processor would control a manipulator arm for placing a soil sample or space dust inside the diffractometer. The registered spectra could be fully processed, including a full identification of mineralogical composition, with transmission of the analyses to Earth. Such a X-ray powder diffractometer could also be carried by lunar or Martian rovers, or it could be carried by a balloon for determining the composition of dust in the Martian atmosphere at different altitudes above the surface. References 17: 12 Russian, 5 Western.

Engineering Model of Martian Atmosphere for Mars-94 (MA-90) Project

917Q0123A Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 1, Jan-Feb 91 pp 3-84

[Article by B. I. Moroz, V. V. Kerzhanovich and V. A. Krasnopolskiy]

UDC 551.51:523.43

[Abstract] The Soviet expedition to Mars, planned for 1994 (Mars-94), will consist of a satellite and a number of descent modules (balloon, small stations, penetrators and small Martian rover). The landing of those modules, the flight of the balloon, and the evolution of the satellite orbit will dependent on atmospheric characteristics. This lengthy article is a summary of the data on those characteristics, and it takes into account the specifics of the project. Since the balloon is the most sensitive to the characteristics, a great deal of attention is devoted to the atmospheric layer below 10 km. The MA-90 model makes no pretense at a global representation of characteristics of the Martian atmosphere. It gives recommendations for a definite season (end of summer in the northern hemisphere), when plans call for the use of the balloon and the landing of small stations and penetrators. The preparation of the MA-90 went far beyond the ordinary limits of systematization and analysis of data published in the literature. Some new work was done specifically for the Mars-94 engineering model: computations of the vertical structure of the lower layer of the atmosphere (0-10 km), including diurnal temperature variations, fluxes of solar and thermal radiation and the wind; computations of general circulation of the Martian atmosphere for the season of the northern hemisphere autumnal equinox; prediction of possible drift trajectories of balloons; partial revision of the upper atmosphere model; construction of a semiempirical model of the atmosphere from an altitude 10 km to the turbopause. The model is being published for the first time in this journal in order to ensure its greater accessibility. Figures 28; references 59: 6 Russian, 53 Western.

Dynamic Properties of Upper Dayside Ionosphere of Venus Determined From Radio Occultation Data

917Q0123B Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 29 No 1, Jan-Feb 91 pp 104-114

[Article by L. N. Samoznayev]

UDC 523.152.3

[Abstract] The altitude profiles of electron concentration obtained by Venera spacecraft using the radio occultation method are compared with direct measurements by the Pioneer-Venus spacecraft. It is noted that there is a systematic difference between the profiles for the different years as a result of the change in the conditions underlying the interaction between the upper ionosphere and the solar wind. Data on solar wind pressure and ionospheric pressure are analyzed for periods of high and low solar activity. The relationship of ionopause altitude and solar zenith angle at different solar wind pressures and activity levels is calculated in order to explain the observed difference in the position of the ionopause when using data from the Venera and Pioneer-Venus satellites within the framework of a gas-dynamical model

of interaction between the ionosphere and the solar wind. The influence of the induced magnetic field, the allowance for which in the system of ionization balance equations explains the altitude variation of electron concentration in the upper ionosphere, is analyzed. The researcher concludes that when solar activity is low, the dynamic pressure of solar wind plasma is, on average, greater than the ionospheric thermal pressure; whereas when activity is high, ionospheric pressure predominates. That primarily is what determines the difference in the behavior of the altitude profiles of electron concentration recorded by the Venera and Pioneer-Venus satellites. The systematic difference in altitude position of the ionopause is governed primarily by a decrease in ionospheric pressure with solar activity and an increase in mean pressure of the solar wind. The observed behavior of the altitude electron concentration profiles is evidence of the regular existence of solar wind-induced, large-scale magnetic fields in the upper dayside Venusian ionosphere during periods of low solar activity. Figures 5; references 29: 7 Russian, 22 Western.

Digital Model of Surface of Phobos

917Q0150 Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA: GEOGRAFIYA in Russian No 2, Mar-Apr 91 pp 43-54

[Article by V. A. Sadovnichiy, S. N. Serbenyuk (deceased), V. P. Belov, V. V. Komissarov, O. R. Musin, B. A. Novakovskiy, I. N. Sytenko and D. A. Usikov, Moscow University]

UDC 521.63

[Abstract] A digital model of the surface of the Martian satellite Phobos is described. In this model, an isoline form of representation of initial data was employed, with topographic maps of the northern and southern hemispheres with a contour interval 100 m prepared by R. Turner (ICARUS, No 33, 1978). The digital model is a set of surface points defining latitude, longitude and distance of a point from the center of the ellipsoid to the surface of Phobos, with the requirement that the density of points be uniform. The selected points were plotted in a network of equidistant parallels, with the number of points on each parallel approximately proportional to its length. The number of parallels was 200; the total number of points was 50,833. These data were processed with a set of programs in FORTRAN with the Pericolor-2000 system. The procedures used in developing the model are described. The final product of this work was a map of surface slopes (in seven scale units) and a map of exposure (orientation) of slopes (prepared in color, but reproduced here in black and white). A series of photographs shows synthesized images of Phobos showing its simulated cratered, pitted, furrowed surface. The described procedures appear to afford broad possibilities for automated compilation of new types of maps whose preparation by traditional methods is difficult. Figures 6; references 6: 5 Russian, 1 Western.

Methods and Results of Study of Aerosol Component of Martian Atmosphere During Periods of Its High Transparency

917Q0177 Kiev KINEMATIKA I FIZIKA NEBESNYKH TEL in Russian Vol 7, No 4, Jul-Aug 91 pp 3-22

[Article by A. V. Morozhenko, Main Astronomical Observatory, UkSSR Academy of Sciences, Kiev]

UDC 523.42-852

[Abstract] In light of the preparations under way for ultimately landing a man on Mars, the reliability of data obtained on the physical properties of the atmosphere and the surface of Mars must be verified. The optical properties of the atmosphere are extremely important because they can be used to determine lighting conditions and the temperature of the underlying layer, as well as, to some extent, the intensity of radiation reflected by the planet. This survey presents a critical analysis of the methods and results of research of the optical properties of the Martian atmosphere when it was highly transparent. The methods are divided into two types—remote and direct, the latter consisting of observations made by Viking 1 and Viking 2 in 1976. The researchers conclude that there are serious grounds to doubt the reliability of estimates of the optical thickness of the Martian atmosphere that are based on the Viking observational data (Colburn *et al.*, ICARUS, 1989, Vol 79, No 1; Pollack, ADV. SPACE RES., 1982, No 2; Pollack *et al.*, J. GEOPHYS. RES., Vol 84, No 6; Pollack *et al.*, J. GEOPHYS. RES., Vol 82, No 28) collected when the atmosphere was highly transparent. They point to the fact that in most cases, when optical thickness was measured several times in the morning and the evening, there was a clear increase in optical thickness as zenith distance decreased. They suggest that the change could easily be explained as the optical thickness decreasing as the altitude of the Sun increased. That would involve dissipation of fog in the morning and condensation of it in the evening. Failure to take such phenomena into consideration could lead to overestimation of optical thickness. Such a possibility should be factored into the engineering models that are constructed for Mars missions. Figures 5, references 40: 20 Russian, 20 Western.

History of 'EPOS' Air-Launched Spaceplane Project

917Q0074A Moscow KRYLYA RODINY in Russian No 11 Nov 90 pp 25-26, No 12 Dec 90 pp 16-17, No 1 Jan 91 pp 4-5

[Article in three installments by Vyacheslav Kazmin: "The 'Quiet' Tragedy of EPOS"]

[Nov 90 pp 25-26]

[Text] The conviction that the future of aviation and cosmonautics will be determined by multiple-use aerospace transport systems is finally held by the overwhelming majority of specialists on the problems of the conquest of space. Of course they point out the successful testing of the Energiya-Buran universal space rocket transport system, where the craft is placed in orbit by a rocket and returned to Earth using wings, like an aircraft.

Why, finally, have they been convinced? You cannot call this idea an absolute innovation. The idea was advanced in the early 1920s, when the drawbacks of using single-use rockets were considered. One of the pioneers of cosmonautics was our countryman Fridrikh Tsander. In the article "Description of the Interplanetary Spacecraft System of F. A. Tsander" published in 1924, he was perhaps the first in the world to propose the use of winged craft for space flights, and showed the advantage of wings over a parachute descent of the orbital craft to Earth. Moreover, in 1927 at the International Exhibition in Moscow, a model of his winged craft for proposed aerospace flights was demonstrated.

Were there no such scientific and technical developments before the Energiya-Buran universal rocket space transport system? In fact there was one. It is more accurate to say that it was not similar, but original, designed in accordance with the priorities and economic development of cosmonautics. A quarter century ago, in 1965 at A. I. Mikoyan's experimental design bureau, a group of specialists, mainly young specialists under the direction of the 55-year-old chief designer, Gleb Yevgenyevich Lozino-Lozinskiy (later he became the general director and chief designer of the "Molniya" scientific production association, where he directed work on the creation of the Buran airframe) began studies and practical work on the Spiral project with the goal of creating a two-stage aerospace system. About a year later, on 29 June 1966, Lozino-Lozinskiy, who was named the chief designer of the Spiral project, had already signed the prepared preliminary plan.

According to this plan, both stages of the aerospace system, with a calculated mass of 115 tons, were simply attached, winged, wide-fuselage craft for horizontal takeoff and landing and multiple use. The system was designed according to a tailless lifting body design. The carrier was a 52-ton (38 m long, 16.5 m wing span) powerful aircraft-booster which would accelerate to Mach 6 and separate, launching from its "back" at an altitude of 28-30 km a 10-ton manned orbital aircraft 8 m long with a 7.4 m wing span. Only 3.4 m of this was the outer wing, and the remaining large part of the bearing surface was the width of the fuselage. This "little bird" was named EPOS (eksperimentalnyy pilotiruyemyy orbitalnyy samolet [Experimental Manned Orbital Aircraft]). It was attached to a tank of rocket fuel for insertion into orbit at hypersonic speed. The development of EPOS attracted great attention from aviation designers.

Let us first note that EPOS was similar both to the Buran, which was constructed later, and to similar craft produced abroad only in its aircraft contours. This was due to conditions required for gliding in the atmosphere. If one looks deeper, the Mikoyan craft is substantially different from other developments of this period, and what is important is that it was developed along an economical path of development. The Mikoyan craft was different in shape, composition, design, which used "hot construction" (construction using heat-resistant alloys, without special thermal shielding), and its movable wing; that is, it differed in everything which provided a good combination of required aerodynamic characteristics at each portion of the flight trajectory. The "winged variant" made it possible to actively use the energy supply of the atmosphere. Thus, for insertion into space orbit, the required energy expenditures were a factor of 6-8 smaller than using any rocket.

This was another matter which was not brought to a conclusion due to the interference of D. F. Ustinov, who was then a secretary of the Central Committee of the Communist Party of the Soviet Union, and curator of the defense industry.

At first nothing foreshadowed the interference. To that point, the general designer himself, while he was alive (Artem Ivanovich celebrated his 65th birthday in August 1970 and died in December), supported with all this authority the group of designers who had started work on the working design of the aerospace system in 1967. Moreover, due to the Spiral project, a space branch of the Mikoyan firm was created in Dubna shortly thereafter. It was headed by the deputy chief designer of Mikoyan's experimental design bureau, Petr Abramovich Shuster. Such attention to their project inspired the specialists; they worked with the inexhaustible enthusiasm of youth, cheerful fervor.

"We really played a trick on Shuster!" recalls Oleg Nikolayevich Nekrasov with satisfaction. He was working on the development of the EPOS navigation and control systems complex. "He was astounded when we presented the control system far ahead of schedule."

To study the characteristics of stability and controllability in various stages of flight and evaluate thermal shielding made of highly durable heat-resistant materials it was necessary to construct three sets of EPOS analogs and flying models on the 1:3 and 1:2 scales, which were named Bor. The analog for studies in subsonic flight (simulation of the atmospheric portion of the descent to landing on return from orbit) was code named 105.11. The supersonic analog was code named 105.12, and the hypersonic analog, 105.13.

In his conversation with the author, the former director of the experimental design bureau of the space branch, Yuriy Dmitriyevich Blokhin (now deputy chief designer of the Molniya scientific production association) stressed the following. "It was characteristic that the basic designs in all variants of the EPOS analogs were executed in one, how shall I say, start-to-finish scheme. What's the advantage in that? First, the construction workload in moving from the subsonic variant to the hypersonic variant rose insignificantly. And it rose only because additional and more sophisticated equipment was installed on board because of the complex problems to be solved. Second, due to the start-to-finish scheme, very little time was needed to prepare for the production of the orbital planes themselves.

Countless tests were conducted, beginning with laboratory studies, wind tunnel models, and analogs in the wind tunnels of the Zhukovskiy Central Aerohydrodynamics Institute, and ending with test stand procedures applied to the various portions of the flight. This made it possible to determine to a high degree of confidence the aerodynamic characteristics of the airframe. In turn, they became the initial data for the developers of various EPOS systems. Then, to refine the results of wind tunnel studies and study the properties of new materials to be used in the construction of the future orbital aircraft, "Bor" models at 1:3 and 1:2 scales were launched with rockets. The construction had to be rather light, but able to function for a long time in extreme conditions. This is especially true in the return to the dense layers of the atmosphere after leaving space orbit. In high velocity flight (the craft would leave orbit at V = 8 km/sec), and extremely strong thermal fluxes are generated in the dense layers of the atmosphere. In the boundary layer air molecules are changed into atoms. Descriptively speaking, they are broken up, and the fragments, electrons, ions, and atomic nuclei form a plasma which greatly heats the surface of the orbital aircraft when it comes into contact with the surface. The front of the fuselage, the edges of the wings, and the tail are heated the most.

As flight speed increased, aluminum and aluminum alloys were replaced in aviation constructions by progressive alloys with a higher heat-resistance. When work was being done on the EPOS project, titanium alloys and heat-resistant steels were already in use. On the horizon were more heat-resistant and plastic materials, beryllium and niobium alloys. However, the durability of the new orbital "bird" was provided not only by the heat-resistant coating, but by its unique aerodynamic characteristics and advanced constructions. The EPOS was designed for a descent from orbit in a self-balancing mode at very high attack angles, up to 53 degrees at a hypersonic quality of 0.8 (the higher the number, the better the lateral maneuverability). The main heat load was absorbed by a heat shielding screen of original design. In such conditions, as was shown by heat and durability testing of the hypersonic analog 105.13 at a special test unit KTPI [expansion not given], maximum heating did not exceed +1500 degrees Celsius. The remaining structural elements in the aerodynamic shade of the heat shielding screen were heated to a lesser degree. Thus, in the production of the analogs one could use titanium alloys, and in some places even aluminum alloys without special coatings such as the more than

38,000 very expensive tiles prepared using extremely complex technology based on thin fibers of pure quartz, which later had to be attached to Buran. This was the first, but far from the last factor in the economical development of this program of the 1960s compared with the Buran program.

Now, we turn our attention to the construction of the screen itself. To avoid disintegration from rapid heating on reentry into the Earth's atmosphere, the screen primarily had to have a high "plasticity" which could be provided, for example, by a niobium alloy. But niobium alloys had not yet been produced, and the designers, temporarily, before the niobium production was mastered, substituted for the material. The thermal shielding screen was made of heat-resistant VNS [expansion not given] steels. The screen was not solid, but made of a set of sheets, according to the principle of fish scales. It was suspended on ceramic bearings. When there were oscillations in the heating temperature they automatically changed shape, preserving the stability of the position relative to the hull. Thus, in all modes the orbital aircraft maintained a constant configuration.

EPOS also had another structural feature: in its descent before entry into the dense layers of the atmosphere, the movable main planes of the wings were placed in a vertical position, becoming a sort of rudder. As a result, they were substantially protected from aerodynamic heating, and this also significantly improved the lateral and flight-path stability of the craft.

When the balancing angle decreased to 30 degrees, the hypersonic quality of EPOS improved, increasing to 1.5. It is true that the heating of the heat shielding screen increased noticeably in this case, but it did not exceed +1700 degrees Celsius, a limit which was tolerable for the alloys in the craft. On the other hand, the possibility of lateral maneuvering in the atmosphere expanded. Without turning on the engine, in pure gliding mode, it was possible to select a landing site in a 1500-1800 km radius. When the turbojet engine, which was provided in the configuration of the EPOS, was in operation, the calculated distance for lateral maneuver at a subsonic cruising speed greatly exceeded 2000 km.

Note that the distance of a lateral maneuver in the descent path from space is a very important condition. The ability to terminate orbital flight in an emergency situation depends upon it. If the maneuvering distance is greater than 2000 km, this means that one could leave orbit on any orbital pass and return to earth at any convenient point selected over an area of millions of square kilometers, that is, the entire Asiatic part of the territory of the USSR.

To improve the landing characteristics in the last atmospheric part of the descent, rebalancing of the craft at small attack angles was provided for through rotation of the wing main planes from a fixed rudder position into a fixed wing position. The lift-drag ratio in subsonic flight with extended outer wings increased to 4, and consequently, the gliding distance also increased.

[Dec 90 pp 16-17]

[Text]Based on the scientific and technical EPOS project, specialists analyzed the possibility of switching from a small one-man orbital aircraft to a multi-crew transport orbital aircraft. A remarkable feature of this design development was revealed. In copying the vehicle on a larger scale, the excellent lift-drag ratio of EPOS was completely retained, and the thermal load in flight at the same attack angle of 53 degrees could even be decreased to +1200 degrees Celsius. Why? Because the local radius of curvature of the surface over which air flowed was increased, and the specific load on the bearing surface was decreased. And there's more. The successful landing characteristics of EPOS were also preserved when EPOS was enlarged, and they were even improved, which is very important. Even in this case they could have been reliably worked out even in flights in analogs of the small orbital craft.

Almost the entire main series of tests of EPOS and its systems were completed on the ground in wind tunnels, in simulation installations, and test stands, and then also in L-18 type flying laboratories. Tests were even conducted to study gas dynamic control in all portions of the flight trajectory. Then the results had to be verified in real conditions, primarily, in flights in EPOS analogs.

The subsonic analog, 105.11, was created by the mid 1970s. The vehicle can even be "touched." It is now on exhibit in the Air Force Museum in Monino near Moscow. The aircraft is provided with aerodynamic controls in durable metal armor: ailerons, a control rudder on the tail, a trim flap. The only thing which looks unusual is the four-legged retractable landing gear. The legs are arranged along the fuselage in pairs, which provided especially good stability as it traveled. And what's more, they were fitted with skids made of wear-resistant metal. The taxiing after landing was short. In a word, this durable four-legged "bird" could land in any spot on more or less level ground, that is, it didn't even require a special airport with concrete paving. The RD-36K turbojet engine, designed by P. A. Kolesov (these engines are now used by the Navy as lift engines on aircraft carrier fighters, the vertical takeoff and landing YaK-38), provided flights from one landing site to another during testing. It is true that this required the front legs to change their "shoes" to pneumatic wheels. This was preceded by a curious incident.

One had to remove the force acting on the chassis in the skid variant in order to move the vehicle along the ground. The EPOS analog was delivered to a test range at the end of a large test airport. A special crane placed it on bare ground, eroded by hot dry winds almost to the consistency of emery. Under the weight of the structure, the skids were firmly fixed in the ground. The test pilot for the Mikoyan firm, Aviard Fastovets, took his place in the cabin. A frenzied roar came from the engine, but the

craft would not move from its place. Water was poured on the strip; it did not help. The pilot had to turn off the engine; the specialists were perplexed about what to do next.

"No one noticed that the director of the test site, Ivan Ivanovich Zagrebelnyy, had come up to us," recalled Colonel Vladislav Chernobrivtsev, who was at the time of the EPOS test program the head engineer of one of the divisions of the Air Force State Scientific Research Institute. "We considered Zagrebelnyy a man who was rather far from pure aviation matters, but he immediately came out with some advice: 'We could break up watermelons in front of your "bird," we have a lot of them here. Then it's sure to start running.'

"Everybody thought he was crazy, but after some thought, we agreed, 'What the hell, let's try it.' Zagrebelnyy made arrangements, and soon two trucks piled high with striped spheres were slowly rolled in front of the feet of the analog. The watermelons audibly splattered to the ground as they liberally spread their slippery pulp over a 70 meter stretch. Lifting the craft with the crane, we placed juicy watermelon halves under all the skids. Fastovets sat in the cabin again. When the engine hit its maximum, the vehicle finally started to move and to everyone's satisfaction, slipped along the strip faster and faster."

Thus, thanks to the cleverness of an airport specialist, the test assignment was completed without significant delays.

Flight testing of the subsonic analog in its skid/wheeled variant began the following spring, in May 1976. At first "subflights" were made: after takeoff the 105.11 would immediately return to the landing site in a straight line. It was tested in this way by Igor Volk, Valeriy Menitskiy (both were later awarded the title Hero of the Soviet Union and Honored Test Pilot of the USSR) and Hero of the Soviet Union and Honored Test Pilot of the USSR Aleksandr Fedotov, who was at that time the chief pilot of the Mikoyan firm. Along with Mikoyan employees, military specialists participated in testing in the EPOS program, namely the pilots and engineers of the Air Force State Scientific Research Institute.

But most of the test flights of the subsonic analog fell on the shoulders of Hero of the Soviet Union Aviard Fastovets. In the same year, on 11 October, he completed a short flight from one ground strip at a spacious airport to another. And in a year preparations began for air launches from under the fuselage of a powerful carrier aircraft. To do this a heavy Tu-95K bomber had been equipped. It was literally a large mother hen, drawing in the "bird" underneath, so that the cabin of the analog was recessed to halfway down the windshield in the bomb hatch, from which the doors had been removed. The air intake of the engine was completely covered in the fuselage of the carrier. The suspension was partially external. The pilot of the analog retained the ability to look through the front hemisphere. To insure that the engine would start, an additional air supply system had to be installed.

At first, in flights without releases, the ability to place the analog in the air flow was verified with special long supports. The engine was also turned on in this position. No special difficulties arose. Only one time the RD-36K engine "sneezed" at altitude and did not produce the required revolutions. But when it was lowered (and it was necessary for work in this mode in the atmospheric portion of the flight after leaving orbit) it produced the required revolutions.

Finally on 27 October 1977 a very difficult stage began. With friendly encouragement by the crew of the Tu-95K, headed by the deputy director of the flight testing service for bomber aviation, Lieutenant Colonel Aleksander Obelov (now General-Major of aviation), Fastovets took his accustomed place in the cabin of the EPOS analog. The restraints tightened the craft to the hatch. The rotors and turbines of all four engines of the carrier began to groan, and after a heavy takeoff, flew into the overcast autumn sky. At an altitude of 5000 meters the craft fell into a "bombing run" course. It was calculated by Honored Test Navigator of the USSR Colonel Yuriy Lovkov so that in case of emergency after release, the pilot of the analog could, without large evolutions, descending only in a straight line, "insert" himself into a landing glide path and land at his airport. Using the aircraft intercommunications device, to which the separated craft was connected, the navigator on board the Tu-95K warned "Ready in zero four"

Aviard Gavrilovich Fastovets, Hero of the Soviet Union and Honored Test Pilot of the USSR recalls:

"Four minutes remained before the release, and we had flown in a rather large break in the cloud cover. Slipping in the restraints into the elastic air flow under the fuselage of the carrier, my 'bird' lightly shook from the pressure of the flow. The trim flap was deflected so that immediately after release diving momentum would be provided, since we were in danger of being sucked into the stream between the fuselages of the two craft. The engine was started; it worked reliably.

"'Engine normal,' announced the crew commander and continued the last check on the systems.

"'Ready in zero one' warned Lovkov's voice over the communication system. But I had already finished everything, and I announced this to the crew of the carrier. Then I heard 'Release' and I knew that Lovkov had pressed the button which would open the locks of the restraints.

"Once it was released the craft's nose dipped sharply, trying to make a steep dive. The trim flap had probably been set too high for rapid exit from the air stream of the carrier aircraft. Countering the rudder deviation, the

"bird" responded well. The autonomous flight continued according to the program without great deviations. That meant that in-air launch was completely suitable for testing of the analog."

It is true that in real conditions the EPOS itself would be launched with a different goal, entry into space orbit, in a different way, from the "back" of a wide-fuselage booster craft. An excellent model of this unique sweep-back craft, with the most advanced aerodynamic shapes, can now be seen in the office of the general director of the Molniye scientific production association. The importance of this type of launch is difficult to overestimate. It revealed the fundamental ability to launch an orbital aircraft virtually at any geographical point above the planet, eliminating the need to strictly limit ground cosmodromes to specific areas. It didn't matter that the EPOS was of small size. It was easy to construct it on a large scale and preserve the characteristics. It is important to know that the closer the launch to the equator, the greater use one can make of the force of the Earth's rotation for acceleration, and in equal conditions one can lift a larger cargo into orbit from the equator.

[Jan 91 pp 4-5]

[Text] The testing of the 105.11 analog continued into 1978, supplementing the EPOS program research on hand. After a launch in the air, one flight was made by Petr Ostapenko, Hero of the Soviet Union and Honored Test Pilot of the USSR. Four more times, it was launched from beneath the fuselage of a Tu-95K, whose crew was now headed by the commander of the Test Aviation Squadron, Col Anatoliy Kucherenko. By the way, this experiment later played a decisive role in aviation destiny of Kucherenko.

But overall the tempo of the implementation of the Spiral program in the 70s began to slow, and that tempo was unable to satisfy any of the designers. A. A. Grechko, who had a passing acquaintance with the 105.11 analog, peremptorily said of the fate of EPOS in the beginning stage of the work, "We will not occupy ourselves with a fantasy." And the marshall was at that time a member of the Politburo of the Central Committee of the Communist Party of the Soviet Union and the minster of defense of the USSR, and the implementation of the prospective project greatly depended on his decision.

This circumstance too is telling. Our country, I think, is the only country where the space department is cut off from the aviation industry. In addition, friction arose between those two sectors at a time when the EPOS analogs required cooperative efforts. The fact is that since 1976, on the insistence of those responsible for the space program (primarily D. F. Ustinov and the minister of general machine building, S. A. Afanasyev), our designers have been forced to chase after the Americans, who at that time were already involved with implementation of the program of Space Shuttle flights. However, from an objective standpoint, we did not at that time need an expensive orbital craft with such a large payload capacity as Buran (many specialists think we still don't need it). The political ambitions of our leaders played an adverse role. They wanted to get revenge after a number of failures in the development of the Soviet space program. After all, the secretaries of the Central Committee of the Communist Party of the Soviet Union and the ministers had already become uneasy about their positions because they had not kept the promises they had made during the long Brezhnev years.

The Ministry of General Machine Building had obtained a government order for the creation of the Energiya-Buran system and began to, so to speak, cover themselves. The Spiral project being developed by G. Ye. Lozino-Lozinskiy and his assistants became, as it were, superfluous. In a report prepared in February 1976 for the Central Committee of the Communist Party of the Soviet Union as a supplement to the requests made to the ministry, the head of the special design bureau of the space branch, Yuriy Dmitriyevich Blokhin, tried in vain to convince the "higher ups" that the work done on the EPOS program and the stock of completed research acquired at a cost of 75 million rubles were, in fact, the only practical basis in the USSR for an alternative solution to the creation of a reusable space transport system in general and for a "hot design" in particular. He also cited the fact that in the United States, McDonnell Douglas, for more than seven years, had been conducting successful research, as well as flight experiments for the purpose of developing a craft with a lifting body by using small X-24-type analogs from which they could later move to the creation of a multi-seat transport orbital aircraft with a "lifting-body" configuration. But it conceded to Rockwell—which had pressed for its own Shuttle project—not for technical reasons at all, but simply because McDonnell Douglas had weaker connections with the Pentagon. (Jumping ahead: now the Americans, disenchanted with the failures and the accidents that have taken place in the launches of the space shuttle, have again done some work on a program whose goal is to create a future aero-space plane with horizontal take-off and landing on standard runways. This craft, according to their estimates, would provide the possibility of multiple flights into space at a tenth of the cost of those of the Shuttle in terms of lifting payloads into orbit.)

Vladislav Mikhaylovich Chernobrivtsev, lead engineer at the Scientific Research Institute of the Air Force, went with the letter to the Central Committee of the Communist Party of the Soviet Union and presented solid arguments in favor of the acceleration of work in the EPOS program. Alas, nothing was taken into consideration by the "higher ups." In April 1976, D. F. Ustinov took the post of USSR minister of defense shortly after the death of A. A. Grechko, and his opinion about the prospects for developing space research remained as before.

The completion of flight experiments on the 105.11 analog happened to coincide with the damage it incurred during a landing in September 1978. This time it was

piloted by a military test pilot, Col Vasiliy Uryadov. Aviard Fastovets, who accompanied the flight in a Mig-23, was observing Uryadov. The landing had to be made into the sun at sunset, and visibility was limited by haze. Not long before this the landing strip had been expanded, and the boundary flags had been moved. They had only cleared it to the end and had been unable to smooth out the ruts and bumps. The flight director was the experienced Hero of the Soviet Union, Honored Test Pilot of the USSR, Maj Gen Avn Vadim Petrov. However, his visibility was poor, too. He misakenly took Fastovets' Mig, which was banking to the left, for the analog. He gave Uryadov the command to turn to the right. Uryadov did this. Descending into the sun, he noticed only too late that he was landing to the right of the landing strip. The quick reaction of the experienced test pilot made it possible for him to turn at the last minute and enter the flag zone, but he didn't have enough altitude. The craft landed roughly on the uneven ground.

The craft was not destroyed; it suffered only fractures in the area of the main frame. Of course the pilots had undergone rough landings. But the engineers and designers.... They say that there is always a silver lining, and this is true. In this case, the specialists had the unforeseen opportunity to actually verify whether their calculations for the strength of the structure under the loads experienced were correct. The results of the verification turned up what they were supposed to. The EPOS analog had withstood this very difficult test adequately. It was quickly repaired. But it never got the opportunity to fly again.

But the fate of the Spiral project was not decided by that incident. Just as in the fate of a number of other projects, the ills of our society were reflected here: the excessive politicization of science, volunteerism, the absence of collective decision making, and the unacceptably great importance of personal relationships among the directors of branches. The most important, I think, was the inability to foresee the prospects for the development of technology and the thoughtless orientation toward foreign experience at the expense of good sense.

It is true that the experience acquired by those who participated in development and testing in the EPOS program was not in vain. Although the space branch of the Mikoyan firm was forced to close shortly thereafter, 48 specialists from Dubna were transferred to the Molniya scientific production organization created to conduct work on Buran. For example, the former deputy director of the production branch, Dmitriy Alekseyevich Reshetnikov, who had made a number of important proposals on how to improve production processes, later became the director of an experimental plant in the Molniya scientific production organization; and the former head of a team of aerodynamicists, Vyacheslov Petrovich Naydenov, became the lead designer heading the mathematical and half-scale modeling in the Buran program. And there's more. Vladimir Aleksandrovich Trufakin, who was then 25 years old, worked in that same team of aerodynamicists. Now he heads the division of trajectory control, is a candidate of technical sciences and is prepared to defend his doctoral dissertation. Victor Ivanovich Sayenko, who worked on EPOS engines, became the director of a division in the Molniya scientific production organization.

The experience of participating in experiments on the EPOS analog had a positive effect on the fate of the pilots as well. For example, Anatoliy Petrovich Kucherenko was invited by the minister of aviation industry in 1980 to "learn to fly" the VM-T Atlant, the transport aircraft that was created on the basis of a strategic bomber design of V. M. Myasishchev and was to carry elements of the Energiya rocket and the Buran orbiter on its "back". Kucherenko was equal to the difficult task, and this earned him the title "Honored Test Pilot of the USSR." Igor Petrovich Volk—Hero of the Soviet Union, Honored Test Pilot of the USSR (now Pilot Cosmonaut of the USSR)—conducted flights on the 105.11 analog and later was the first to fly the Buran analog. He made a substantial contribution to the flight testing of the automatic landing system of the reusable orbiter.

But there is still something else which is interesting. After all, from the standpoint of aerodynamics, our orbital aircraft is thoroughly debugged. Based on this experience, Gleb Yevgenyevich Lozino-Lozinskiy, laureate of the Lenin and State Prizes of the USSR, Hero of Socialist Labor, and Doctor of Technical Sciences, delivered a report in October 1989 at the Fortieth Congress of the International Astronautical Federation in Malaga. The conference was attended by representatives of 130 organizations from dozens of countries. Lozino-Lozinskiy proposed the implementation of a reusable aerospace system in which the first stage could be the extremely powerful An-225 "Mriya" aircraft, which is capable of launching from its "back" a small orbital aircraft with a suspended fuel tank, the only expendable element in this design. The remaining portions of the system are designed for re-use. The system has all the advantages, especially the promptness and reliability of in-flight launches.

This proposal, which became a real sensation, promises great advantages to the world community in the conquest of space.

Prospects For Space Materials Processing

917Q0137 Moscow ZEMLYA I VSELENNAYA in Russian No 2, Mar-Apr 91 pp 21-25

[Article by A. V. Yegorov, Splav Technical Center, USSR Glavkosmos]

[Text]

The Opportunities of Space

Remember when the US conducted a competition among children, and they had to think up a space

experiment? One boy proposed an experiment to see how a spider would spin his web in weightlessness.

The experiment that the schoolboy suggested could be considered an experiment in space technology because the goal is to study the **technology** of spinning webs in space. Intuitively, the young investigator assumed that Earth technology would be no good in weightlessness. The first threads of the web are formed on Earth by descending from something a branch, for example. But how could that be done in space where there is no up and down? One would have to "think up" a new technology. And it would be very interesting to see how the spider handles solves the problem.

Similar questions have been posed by scientist-engineers who have conducted technological experiments in space. Unlike the spider, who became confused in weightlessness and began to spin a "disorganized" web, the specialists in space technology had elementary ideas that had been formulated long before by K. E. Tsiolkovskiy. But of course there were still many questions. How would crystals grow in space? What would happen if alloys of different metals uncombinable on Earth were combined? In other words, space technology, as a new area of human knowledge, at first studied the features of industrial processes associated with the production of various materials aboard a spacecraft.

In space, there is much which is not very similar to what we find on Earth. Water boils differently: there is none of the typical churning of the water, and steam doesn't burst out of the spout of the teapot. In space, a candle burns differently. On Earth, the air heated by the flame rises and is replaced by fresh air that is rich in the oxygen that is essential for the burning process. In space, however, if an influx of fresh air is not artificially provided, the candle goes out when the oxygen around the wick is used up.

In space, in the absence of gravity, other forces begin to appear—for example, molecular forces. When liquid wets the walls of a container, pouring the liquid out is a problem in weightlessness. On the other hand, if the walls are not wet, the liquid seems to "hover," hardly touching the walls, and at the first opportunity it tries to break out of the place of its imprisonment.

The examples could go on and on. But what we have been talking about are nothing more than simple physical phenomena. What happens with them in the weightless conditions to which we are not accustomed is, to some extent, logically predictable. Other, more complex processes—for example, the growth of crystals in weightlessness—are much harder to theorize about in detail. Here direct experiments and the accumulation of knowledge are necessary.

On Earth, weightlessness can be created for only a short period of time. Many of you have experienced it for an instant: in an automobile, when the road suddenly slopes down; in an airplane, when it goes into an "air pocket." Cosmonauts in training must go aloft in flying-laboratories where they are accustomed to weightlessness for tens of seconds while the plane performs a special maneuver—a "zoom," i.e., it flies along a ballistic curve (close to a parabola). In the course of those flights, brief production experiments have been conducted. They have been of either a fundamental nature or a demonstration nature.

But a proper study of those processes in weightlessness can only be done in space, on rocket-probes, satellites, and orbital stations.

Is Space Technology Necessary?

It is natural to ask, Why are technological studies in space needed? They are needed to satisfy the curiosity of scientists. But, look, it costs a great deal of money to conduct an experiment in space. Is such spending justified? The answer is clear—yes, it is justified. Space (and only space!) provides us with unique physical conditions which cannot be achieved on Earth. Those conditions are opening the way for producing new materials with undreamed-of properties or materials which are very difficult and expensive to produce on Earth.

Of course, we are not talking about producing tons of materials, or even hundreds of kilograms of materials. That will hardly be realistic for decades to come. Space technology has not yet reached that level. For now, we are talking only about manufacturing unique samples of materials whose appearance will give a new impetus to the development of science and technology and will stimulate technical progress. That will justify the high cost of such materials.

Today, with ground-based technology, several "unparalleled" samples of materials have already been created—for example, semiconductor crystals valued at several million dollars per kilogram. At such a price, it is entirely feasible to recover the costs associated with the launch of a rocket, its operation in space, and the return of the finished product to Earth. Consequently, profit-making space-based production is possible. But, undoubtedly, it is a task of the future. The conditions are not yet right for it. First, we need a higher level of development of rocket-space technology. We need to create specialized, long-term space platforms which are relatively inexpensive and are well provided with energy. Fairly small unmanned production complexes will work on those platforms to produce certain materials. We need to set up a regular freight flow: take raw materials there, bring finished product back. Second, we need to find out which materials are best produced in space and what technology is best used. That will mean first performing a comprehensive complex of theoretical and experimental research.

The Beginning of Systematic Experiments in Orbit

In the 70s, such work was begun by this country and by countries abroad. Among the first experiments were those done back during the joint Apollo-Soyuz space

mission and continued on the Salyut 4, Salyut 6, and Salyut 7 space stations. Those experiments consisted of basic research. Various production processes were tested, and experiments were conducted with the most varied of materials: metal alloys, composites, semiconductors, and glasses.

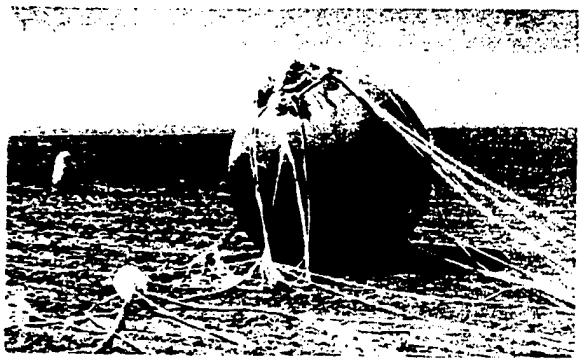
But in April 1985, the Soviet Union launched the Kosmos-1645 satellite. After a 13-day flight, the satellite's recovery capsule delivered to Earth production installations and samples of materials produced in space. From that time on, the launches took place annually. In 1988, the satellite took the name Foton. In April 1990, the Foton 6 satellite returned to Earth after a 16-day flight. As Foton 5 before it, Foton 6 carried Soviet equipment as well as equipment created by specialists in France. The costs—which weren't small—associated with launching that equipment were paid for by the French National Center for Space Research (CNES).

The Most Important Directions Being Taken in Space Technology

First, there is the cultivation of high-quality semiconductor crystals. They are needed by the burgeoning microelectronics industry and for the creation of unique lasers and infrared imagers, sensitive nuclear radiation sensors, and unique instruments for physical research. As the first experiments showed, for semiconductor crystals grown from a melt, weightlessness provide conditions that are more favorable than those on Earth. The thermal convection required on Earth is absent there, as a result of which the defects associated with convection are absent in the crystal. That explains the different nature of the interaction between the growing crystal and the wall of the crucible is also different (it is feasible to grow crystals without a crucible).

Second, the founding of glass in space is promising. Today's industrial glasses are multi-component mixtures. The different components differ greatly in their specific densities. On Earth, in a melt, those components try to stratify, the denser materials sinking to the bottom of the crucible, the less dense materials rising to the top. The melt must constantly be mixed. But when the glass melt hardens, mixing is impossible, and local sheaves of denser components are formed in the glass (cords). Such glass is defective. In weightlessness, there is no stratification of melt components by specific density.

Space biotechnology has become an independent area of research in recent years (ZEMLYA I VSELENNAYA, No 4, 1989). Initially, the primary work here was concentrated on obtaining extremely pure biological preparations. One of the purification methods used for biological preparations was electrophoresis. But the idea of using space to grow perfect protein substances has come to the fore for the time being. Such crystals are desperately needed for in-depth research on proteins involving X-ray structural analysis. On Earth, protein crystals do not grow into high-quality crystals. Only in space can the problem be solved. The first experiments confirmed



Recovery capsule of Foton satellite after landing.

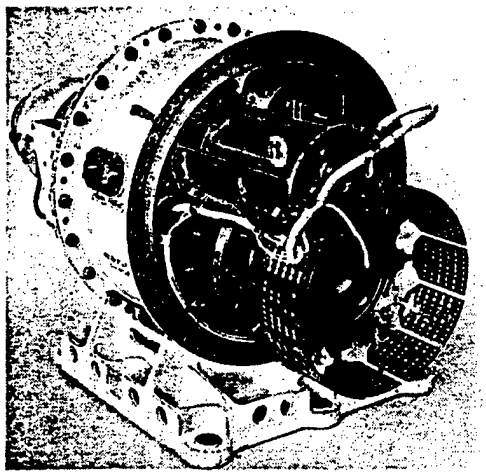
that. It is with good reason that protein crystals have been grown on Soviet space stations in the context of commercial contracts with foreign specialists. A rather extended period of time is required to grow them (no less than two weeks), and abroad there are no suitable spacecraft for that yet.

The development of space technology has required the creation of special on-board production equipment—various electric furnaces, crystallizers, and units for electrophoresis. In all such complex industrial systems, in which, for example, semiconductor materials are melted and crystallized, the gear must be as light, compact, dependable, safe, and durable as possible must use as little energy as possible. Frequently, such requirements conflict with each other. For example, safety and a high degree of reliability require, as a rule, an increase in mass and size (as a result of redundancy, greater durability, etc.). But that, in turn, leads to higher energy consumption.

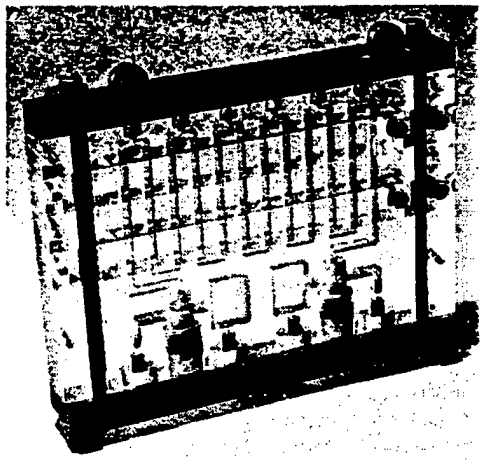
What Has Already Been Done?

All the Foton satellites that have been launched have carried the Zona 1 unit (its next, updated version is Zona 4)—an electric furnace for growing semiconductor crystals by means of using zone melting. In the initial specimen of the material, which is 10-20 mm in diameter, a narrow zone (about 20 mm) is melted, and by slow movement of the specimen relative to the heater, the narrow zone is gradually moved from one end of the specimen to the other. A purifying process takes place, and the crystal grows. In weightlessness, the melt zone can be maintained by the forces of surface tension, and it does not spill over, even if the specimen is not in contact with the walls of a crucible. The advantage of this crucibleless zone melting is that the growing crystal is not contaminated by impurities from the walls of the crucible and grows freely, without the mechanical effects of the crucible walls.

Zona-4 unit.



Splav-2 unit.



Electrophoretic core of Kashtan unit.

Recall that on the ground, crucibleless zone melting of a number of semiconductor materials (for example, germanium) is not feasible. Single crystals of germanium (pure and alloyed) and gallium antimonide were obtained for the first time ever in space, in a unit in operating in automatic mode and using the method of crucibleless zone melting. Those crystals are typical representatives of the most interesting classes of semiconductors.

The Splav-2 unit is also an automatic electric furnace created for the Foton satellite, but it effects crystallization from the gas phase and volume hardening. Splav-2 has a magazine that contains 12 metal capsules which are loaded one by one into the furnace. On the end of each capsule is a code carrier which contains the coded program for the experiment. Just before the capsule is loaded into the furnace, that information is read by an electronic device and transferred to the control memory. The Splav-2 is used for experiments with semiconductors and glasses. Experiments to produce glasses with variable indices of refraction have been especially successful.

Biotechnological experiments on Foton have been conducted in the Kashtan unit, in which biological substances are separated and purified by electrophoresis in a free fluid medium. Protein crystals are also grown.

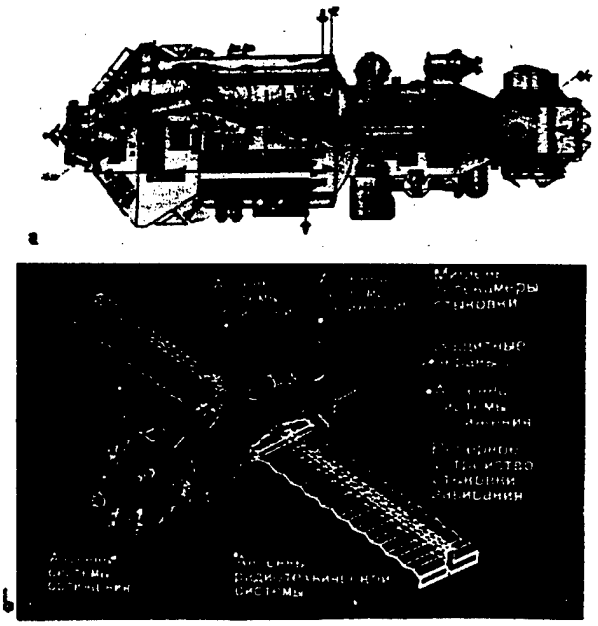
The main assembly of the unit is a thermostat which maintains a temperature of +4°C (the most favorable temperature for biological preparations).

Depending on how the unit is to be used, the thermostat contains either an electrophoretic core or a biocrystallizer.

High-quality protein crystals are needed in today's biology and medicine, but in on the ground, growing crystals from solutions of proteins is, in the majority of cases, extremely difficult.

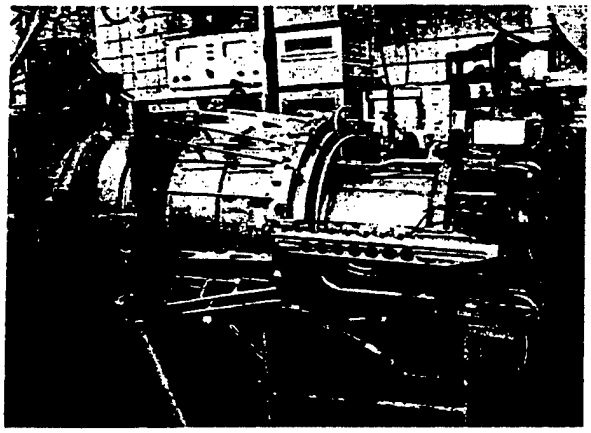
The Kristall Module

Experiments in space technology occupy a special place in the program of work to be done by crews of the Soviet long-duration orbital station Mir. The Kristall module docked with the station on June 10, 1990 (ZEMLYA I VSELENNAYA No 4 1990, p 52). It is equipped with a number of on-board production units and has become a real production laboratory in space for the performance of various experiments and for the production of materials via space-based technology. Among the production units on the Kristall module are two furnaces, Zona-2 and Zona-3, which are more advanced than those on the



Kristall docking production module. Upper figure: general appearance (length 13.73 m, maximum diameter 4.35 m, mass 19.5 tons, payload mass 10.6 tons). Lower figure: deployed elements of the structure.

Key: clockwise from top left—approach system antenna; approach system antenna; docking television camera target; protective screens; approach system antenna; reference device for hover docking; antennas of electronic system; antennas of approach system; antenna of command radio link.



Zona-3 unit.

Foton satellites. They are revealing new possibilities for conducting systematic research and experiments in the interests of the nation's economy.

NPO Energiya Consortium Developing Solar Sail Spacecraft, Earth Illumination System

917Q0163 Moscow DELOVOY MIR in Russian 21 Jun 91 p 2

[Interview with N. Sevostyanov, general director of the Kosmicheskaya Regata Consortium of the Energiya Scientific Production Association, by Lyudmila Papayants: "'Kosmicheskaya regata'[Space Regatta]"; first two paragraphs are DELOVOY MIR introduction; questions raised by Papayants are in italics]

[Text] **A consortium with that poetic name [Space Regatta] has been formed in the Energiya Scientific Production Association. It is made up of the leading enterprises of the country in the area of space hardware. Specialists of the Energiya Scientific Production Association participated in the International Competition in Honor of the 500th Anniversary of the Discovery of America by Columbus, which was announced by the anniversary commission of the U.S. Congress for the development and construction of solar sail spacecraft.**

In the summer of last year, the results of the first stage of the competition were summarized. The team of the Energiya Scientific Production Association became one of its four prize winners. The team's technical proposals, along with the proposals of teams of the United States, Japan, and Italy, were judged the best ones, which is why the next task should be the implementation of the designs. That's what the Kosmicheskaya Regata [Space Regatta] Consortium was established for. Its specialists will engage in the development and construction of spacecraft of a new type on the basis of unfolding structural members. Such structures will also find broad application in the national economy.

The launch of a multipurpose solar sail spacecraft to the planets of the solar system is planned for October of next year. That craft is being developed right now at an accelerated pace at the scientific production association.

"This is the first business-related job done by the consortium, which was established on a joint-stock basis," said N. Sevostyanov, the general director of the consortium. "And after that, we intend to conduct an experiment on illuminating the surface of earth from space. The idea of this experiment consists in using a solar sail craft as a solar space reflector. The problems are not easy ones and require the creation of vehicles that represent new levels of technology."

There are no doubts that all these developments, projects, and then launches will cost more than 100 million rubles. What kind of a payback is there on those expenditures? The question is not an idle one, especially now, when the economic crisis has affected all spheres of the national economy. Who is financing such expensive projects?

"Unquestionably," N. Sevostyanov agreed, "those operations represent large expenditures. But, I assure you, they will not be a heavy burden on the economy. The

state is not financing those operations. Nevertheless, in light of the great end result, it makes good sense to share in the implementation of those projects. A great practical result will be achieved by the development of systems of the space-based illumination of the dark side of Earth with reflected sunlight. Our system will make it possible to illuminate large cities, as well as cities above the Arctic Circle (mainly in winter, when polar night sets in there)."

Did I understand you correctly: You will be able to take orders (for a certain fee, probably) for illumination and to transmit commands to satellite illumination systems in space?

"That's roughly what I'm saying," Sevostyanov said. "Space illumination will help to speed up the construction of certain facilities on Earth that are located in hard-to-reach regions that are far from sources of light. After the accident at the Chernobyl Nuclear Power Plant, nuclear plants will, of course, be built far from population centers. The expenditures on their construction will increase, and a considerable amount will go for illuminating the construction site."

From the very outset, specialists built a commercial basis into those space projects. According to foreign estimates, such illumination is dozens of times less expensive than ground sources. Natural resources, including petroleum, will be saved. Such illumination will make it possible to redistribute the generation of electric power. Calculations show that on a cloudless night, the illumination from a space reflector could reach 30 lux, which corresponds in brightness to 300 full moons. By comparison, the brightness of night street-lighting is only on the order of 10 lux. The question of the ecological consequences of such illumination will undoubtedly also interest many people. What will its effect be on nature and on man?

"Calculations have shown that no adverse effect occurs," N. Sevostyanov says. "I would also like to talk about another area of the work being done by the consortium. In the future, plans calls for the development of passive reflectors of electromagnetic waves for global communications systems on the basis of large unfolding structural members. Many countries of the world are now working on that problem.

"Commercial projects will be financed by the formation of stock capital. State and public organizations, cooperatives, private organizations, foreign firms, and individuals can be stockholders. We have calculated that the first experimental space illumination system, which is designed to serve eight to 10 large cities, will yield annual revenues of not less than $120 million. Over five years of operation (1995-1999), the revenues will be on the order of $600 million. The net profit—about $300 million—will be distributed in shares. At present, financing is being carried out within the framework of the Columbus-500 space sailing regatta project and by the founders of the consortium."

Solar Sail Spacecraft for Columbus-500 Project

917Q0179 Moscow IZOBRETATEL I RATSIONALIZATOR in Russian No 1, Jan 91 pp 34-35

[Article by A. Shvartsburg, from the Konnektor enterprise: "Celestial Sailboat: The Eve of the 21st Century"; first paragraph is poem from Seydlitz (Zeyedlits)]

[Text] *Atop the blue waves of the ocean,*
With only the stars in the heavens above,
The lonely ship is rushing,
Rushing under full sail ahead...
No captain is heard on its deck,
No sailors aboard to be found,
But the rocks and the hidden shoals
And the storms are child's play in its path.

It is difficult to find a more accurate description of what Martians will see in two years than the one given by Lermontov. His romantic vision may become a reality at the end of the century. In October 1992, an exciting race will begin, one of the greatest races in history—a race from Earth to Mars! The year 1992 is the year that marks the start of the international Columbus-500 regatta, a competition for the Christopher Columbus Cup that was announced in December 1988 by the U.S. Congress in honor of the 500th anniversary of the discovery of America.

The concept of moving under solar sail, like everything else in our civilization, first became widely known from science fiction—from Arthur C. Clarke's book *The Wind From the Sun* (1963) about a manned flight to the Moon—although the possibility of such flight was alluded to by Tsander back in 1924. Variations on the theme of using a sail in space were developed technically in the mid-70s in the framework of the preparation of a number of flights in the USSR and United States—in particular, in NASA's preparation for the Galileo project. The path from first plans to reality took about 15 years, about as long as it took Columbus; the organizers also ran into problems with finances.

Solar sail spacecraft move because of the pressure of solar photons and the solar wind on the reflective surfaces of the sail. That pressure, although very small—near the Earth, 10^{-5} N/m^2—nonetheless acts continuously without expending fuel and, in the absence of external tractive resistance, can gradually accelerate the craft to high speeds or, conversely, can brake it to low speeds. The force of solar pressure drops by ½ as one moves away from the star, just like the force of gravity, which is why their ratio for a given structure is always the same. That coefficient (K) also determines the efficiency of the solar sail; to achieve substantial speeds in real time, the coefficient must be no less than 0.3. Up until recently, there were no designs with K = 0.1, and that's why there was no interest in them and they were not built. The ratio of the area of the sail to the total mass of the craft needed to provide the stipulated K—a ratio that is obviously equal to the ratio of the accelerations of

the force of gravity and the solar pressure in any orbit, multiplied by K—comes to more than 600K m^2/kg or, as a minimum, 200 m^2/kg to obtain an acceptable K. That, with allowances made for the hull of the craft, the instruments, the payload, the communications equipment, etc., dictates a surface density of the sail material of no more than 2-3 g/m^2 and a sail area in the tens or hundreds of thousands of square meters, since the payload mass is proportional to the area.

The creation of such sails requires the use of extremely flexible, lightweight films that are much thinner than conventional polyethylene, are highly reflective, and can be folded compactly at launch time. The mast and the hull must be made of high-strength, lightweight materials. Similar problems were confronted by aircraft builders 80 years ago and, as we know, were solved, and that has instilled the inventors with a belief that success is possible. Moreover, a sail designed to work in an environment of negligible forces must be assembled on Earth at a gravity of 1g and must withstand accelerations of up to 5g during the orbital injection leg (for normal deployment and operation of the sail, it must be placed into a high near-Earth orbit, because at altitudes of up to 2,000 km, the material could be damaged by the upper layers of the atmosphere). The problem is being solved by assembling the sail on Earth in folded form and using heavy-duty shells that are jettisoned just before deployment. Space sailorcraft can make flights around the Earth and to and from the inner planets and the outer planets, perform various maneuvers in geocentric and heliocentric orbits, sail close to the wind and tack, move outside the plane of the ecliptic, travel beyond the solar system, and even fall to the Sun. That last variation is an original means of burying radioactive waste. Nor is the use of the reflective surfaces of the sails as part of a reflecting telescope being discounted. The Columbus-500 competition has the following goals: to clearly for the first time ever demonstrate these methods of exploring space, ascertain the features of the behavior of the structural materials in flight conditions, perfect autonomous and controlled navigation with the execution of various evolutions, stimulate interest in science education and in the study of space, to spur the development of new technologies in allied fields. Finally, the organizers intend to derive satisfaction from the competition and present that opportunity to the many supporters—it is, after all, a race. And there is also a scientific program.

The rules—developed by a presidential commission set up in Washington to coordinate efforts and to support the participants and headed by Gen James Abrahamson, the pioneer of the Star Wars program, who had apparently decided to devise several pirate sails for such battles—are simple:

1. Like Columbus, one can use external energy sources only (dispense with propellers and paddles).

2. Like Columbus, the navigators will determine their course by the Sun and stars.

3. The "displacement" of each caravelle must be no greater than 500 kg, and there will be a total of three, as Columbus had. They will represent Europe, America, and Asia—the continent from which Columbus sailed, the continent he sailed to, and the continent he had intended to reach. Each craft will have on board 1 kg of obligatory payload—a set of treasures of the civilization of the continent which the craft represents (for example, America has the Declaration of Independence and a computer chip; Europe has a Bible and a portrait of Queen Isabella, who sent Columbus on his journey; and Asia has the Bhagavad-Gita). Moreover, all will have a portrait of Columbus, Queen Isabella's charter, and excerpts of the best compositions on the theme "Columbus and the Study of Space."

4. The craft will be launched by the same vehicle to a designated orbit, where they moor, open like an umbrella, raise their sails, and, flying past the Moon, set out for Mars. The winner is the craft which reaches the Red Planet first or, failing that, the one which gets closest to it. Intermediate goals are the closest approach to the Moon and achievement of escape velocity (the exit from the harbor to the open ocean). Everything else is left up to the discretion of the candidates.

The results of work by groups from the United States, USSR, Great Britain, Italy, Canada, and China who decided to participate in the Columbus race were examined in April 1990 at the Carnegie Institute in Washington.

Among the proposals made by the Americans were the following:

1. "Sunflower." An aluminized sail in the form of a flat disk with a radius of 85 m and a weight of 180 kg, equipped with an antenna, television camera, solar panels, and a command module with K = 0.2. The project, which costs $15 million, was developed by Johns Hopkins University in conjunction with NASA, the University of Maryland, and Westinghouse.

2. A square sail presented by Emerson La Bombard from the World Space Federation in Pasadena in conjunction with McDonnell Douglas, the U.S. Planetary Society, the University of Utah, and Weber State College.

3. An extremely light (20 kg total), small (1000 m^2) sail made of kevlar stretched on battens. The sail rotates, using centrifugal force to keep them in a plane. This project, which was carried out at the Massachusetts Institute of Technology in Boston, was estimated to cost $3 million, but was not suitable because of its K = 0.08 value, which is very small.

4. The flat hexagon of the Canadian Space Society is also stretched on rotating battens. It is equipped with instruments for magnetic studies.

Professor Roberto Stalio from Trieste University talked about the project of the group, which is headed by the Aeroitalia company. Their sail is made of aluminized

mylar and has an area of 10,000 m^2. The Chinese version is similar to the third design from the United States, but is larger. Steve Temple and Gordon Oswald from the British firm Cambridge Consultants constructed a circular sail with a radius of 140 m from polyester film folded like an accordion. The battens, which are made out of flexible carbon fiber, extend when they are released from the shell, because of their own elasticity. The curvature of the sail, with a shape that can be changed by rotating the battens, gives the skipper (on Earth, presumably) the ability to control the rotation of the craft around its own axis and the momenta in two directions. The total mass of the craft without its shell is 300 kg, of which 60 kg is payload, and K = 0.30.

The British clipper is called the Nina in honor of Columbus' caravelle, and the flight to Mars will take 200 days. That figure is not far from the length of typical flights to Mars, and the craft of the Cambridge shipbuilders is considered one of the best foreign craft.

Our team is working under the aegis of the USSR Academy of Sciences, in which the Soviet Preparatory Committee, headed by Academician Yu. Gulyayev, was formed. The craft is a two-vane sail with a total span of 17 km, a width of 7 m, and a mass of 463 kg (without the shell). The craft was built at the Rossiya Youth Creative Union of the Scientific Production Association [NPO] of Machine Building under the direction of Vladimir Bazanov and Aleksandr Lavrenov. They achieved a record K = 0.37 with a payload of 49 kg. The film—2.25 microns thick, made of polyamide, and aluminized on both sides—has a surface mass of 3 g/m^2, and the masts are made of a flexible amorphous alloy. The film roll is deployed by centrifugal force when the craft is rotated around its axis. Infrared targets and sensors keep the sails flat. The required rigidity of the sail is achieved by controlling the frequency of its rotation, which is maintained by placing the vanes at an angle to the solar rays (as in windmills).

One of the unusual problems which had to be solved by the designers was the electrical neutralization of the sail, which is charged by electrons of the solar wind. (The constantly increasing potential of the craft would lead to grave consequences.) A neutralization system and electronic injectors regulate the potential of the sail and provide the navigators with an attitude-control engine. Seven sensors observe the Sun and Earth, using them to verify the course of the craft. Nearby is a television camera. The electric current for the craft's systems is developed by a solar panel with an area of 4 m^2 and thermal elements with a radioisotope heater. Information is transmitted to Earth from the craft by a telemetry system with a reception range of 400 million km. Various settings are received from Earth by a command system with a sensitivity zone of 100 million km. The craft also has other equipment.

The science part of the mission program, developed by the Central Design Bureau for the Building of Unique Instruments of the USSR Academy of Sciences, includes a study of the red-blue frequency shift of radiation in the gravitational field of the Sun—a study that is an experimental refinement of a number of points of the General Theory of Relativity. Another area of interest to the captains is the measurement of the magnetic field and space plasma. Instruments and methods for that were proposed by the the Institute of Earth Magnetism, the Ionosphere, and the Propagation of Radio Waves's Division of the Dynamics of Space Plasma, under the direction of Dr Phys-Math Sci A. Ye. Reznikov. A Leningrad firm, Nauka-Servis, is providing substantial assistance to the Soviet group in terms of financial and juridical consultations and advertisement. Congressman James Symington, co-chairman of the Columbus-500 project, noted at an April meeting in Washington that "the participation of organizations with such a high level of technical expertise is an acknowledgment of the significance of the project to expansion of the technological boundaries of space transportation in the 21st century."

"In selecting the participants of our competition and discussing its details, we sense a surprising atmosphere which combines romantic dreams and business entrepreneurship, an atmosphere that is characteristic of mankind's attempts to expand its horizons. However, the key lesson which Columbus gave us was the example of the international composition of the crews of his ships. The great seaman was the first to do that, and he was just about the first to return to port without a single loss of life." That is written in the foreword of the Soviet project. In wrapping up this article, I would like to turn the reader's attention to one final point.

After the article was submitted, we were informed that in December 1990, the scientific station Almaz will be launched in the USSR. On board Almaz, samples of the materials of our sail will be tested in situ. The possibility of simultaneously testing British materials according to a signed agreement is being worked out.

'Bivni' Spacecraft Docking Simulator

917Q0176 Moscow KRASNAYA ZVEZDA in Russian 31 Aug 91 p 4

[Article by KRASNAYA ZVEZDA correspondent Colonel A. Andryushkov, cosmonaut candidate from the USSR Union of Journalists, from the Baykonur Cosmodrome, under the rubric "A Few Pages of a Space Diary": "The 'Bivni' of Baykonur"; first paragraph is KRASNAYA ZVEZDA introduction]

[Text] **Minutes remained to the moment of approach and docking. The crew of the Soyuz-TM spacecraft watched the orbital station on the display screen and visually through the optical sight. The automatic equipment worked irreproachably. The docking port approached slowly, increasing in size. And suddenly the picture changed: The Soyuz moved to the side, and the spacecraft began to twist around its axis. "Switching to manual!" the commander more exhaled than said. Silence set in at the Mission Control Center....**

In the history of our space program, there is not a word about why that simulator for the training of crews for an orbital flight was called "Bivni."

"Most likely, at one time they classified the new item with that kind of an exotic name," was the opinion of Colonel V. Afonin, deputy chief of the department of the comprehensive training of cosmonauts. "Is that really what's important?"

True, it's not the name of the simulator, but its purpose, the job it does, that is important.

"More than 10 years ago," Vladimir Semenovich says, "the space industry developed a unique simulator for the training of cosmonauts at Baykonur. The primary difference between the 'Bivni' and the equipment which is at the Cosmonaut Training Center imeni Yu. A. Gagarin is its advanced simulation of the actual conditions during the stages of the approach and docking of the Soyuz-TM spacecraft with the Mir orbital station...."

The "Bivni" was conceived as a simulator to be used for the maintenance of cosmonaut skills in the manual control of space freighters at the stage of docking with the station. Several cases of the failed docking of spacecraft in orbit preceded that. The crews would rendezvous with the Mir station in automatic mode. But even the most reliable equipment at times malfunctions. And then man has to join the work. From a supervisor he switches to a new capacity—the active operator. The more frequent the launches of spacecraft became, the more urgent the problem of their manual piloting was. Returning to Earth, cosmonauts spoke more and more insistently about the need for the development of a new method of docking with the orbital station. Theory required verification by practice. First on the ground. Thus the foundation of the development of the "Bivni" was laid.

"In the late 1970s," Col. Afonin says, "they brought the new simulator to Baykonur. Procedural instructors at the Cosmonaut Training Center who were responsible for the reliability of the control of orbital manned complexes were the first to test the effeciency of the 'Bivni.' The results were very good...."

Soon the evaluation of the simulator by experts was confirmed in space. The mission of Vladimir Dzhanibekov with a French cosmonaut was worked out in advance on the "Bivni." And although the Soyuz came to the orbital station, just as earlier, in automatic mode, the cosmonauts were ready for surprises. The space "scenario instruction" did not make them wait. The malfunction in the automatic spacecraft control loop began during the approach to the Salyut-7 station. Vladimir Dzhanibekov took control. And the entire world saw with what exquisite precision man performed complicated maneuvers in space, maintained all the conditions, and docked softly with the orbital station.

Yes, that incident is an old one. As before, automatic mode is the basic mode of piloting in space. But all crews, without exception, train on the "Bivni" in the manual control of the spacecraft before liftoff from Baykonur. The training sessions conclude with a rigorous examination. Neither experienced nor novice cosmonauts are given an easy time People go into space without crib notes. Knowledge is what helps at a difficult moment. The most recent example of that is the manual docking with the Mir that was made by the crew that is in orbit—Anatoliy Artsebarskiy and Sergey Krikalev. Before the mission they developed sharp eyes and became "skilled hands" and on the "Bivni" at Baykonur.

The simulator knows practically no rest. Today,the team of Col. Vladimir Afonin is working on it. Flying with him into Baykonur were Maj. Yevgeniy Zhuk and Maj. Oleg Polovnikov, specialists in the manned space program; Capt. Dmitriy Churkin, manual docking instructor; Sr. Lt. Andrey Ogarev, instructor in the integrated control of the Soyuz-TM spacecraft; and Sr. Lt. Andrey Kuritsyn, a specialist in the control of the Mir station. Their primary task is to train two crews for an orbital flight. Heroes of the Soviet Union Col. Aleksandr Volkov and Takhtar Aubakirov—and their backups, Hero of the Soviet Union Col. Aleksandr Viktorenko and Maj. Talgat Musabayev—are training for an autumn launch.

After a routine session of many hours (the work on the "Bivni" simulator proceeds on a real time basis, duplicating a space mission to the most minute detail) I approached Honored Test Pilot of the USSR and Hero of the Soviet Union Aubakirov:

"Takhtar," by right of longstanding friendship I called him by his first name, "tell me, what do the training sessions on the 'Bivni' give you? How is your work on mastering the space program going?"

The face of the cosmonaut-test pilot who had exited the simulator still had traces of fatigue on it, and his flight suit was damp with dark circles of perspiration on his broad chest. The road into space is not easy, and the salty taste of sweat is well known to those traveling it. Aubakirov has to work doubly hard, because the course of his training has been squeezed into a very short time.

"It was easier for me to test aircraft." As well as I know the man, he never strove to look "made up." Exceptionally honest and devoid of conceit, Takhtar evaluates himself with strict objectivity. In telling me about his training session, he tells it to me the way a friend would: "You know yourself that to master the piloting of the Soyuz-TM spacecraft is hard even from a theoretical standpoint. The habit of finishing what I've started doesn't let me weaken and retreat. But that in itself wouldn't be enough, if it weren't for the help of the crew commander, Sasha Volkov. We've been acquainted since way back through testing work, but we've really gotten to know each other now, I think. Volkov has space-flight experience, and I'm a novice. He has sort of taken me by the hand and is leading me over unfamiliar terrain, explaining where to best put my foot so I don't stumble.

I know that during the training sessions back at Zvednyy [Gorodok], I didn't do everything cleanly. But the commander's self-restraint didn't fail him once. Here, at Baykonur, I feel much more confident. The 'Bivni' in its simulation shows every instant of the flight. At times I forget that I'm in a simulator, the appearance of the space flight is so realistic. When the automatic equipment fails and you switch to manual control, when fractions of a second decide whether you'll turn out the winner or become an 'accidental' artificial Earth satellite, there's no time to talk, and we've already learned to understand each other intuitively. The docking with the station in manual control is going smoothly. The examiners will evaluate it."

The examination training sessions of the crews of Col. A. Volkov and Col. A. Viktorenko coincided with the peak of the August heat at Baykonur. But the people and the simulator worked, unabated.

"The instructors," says Afonin, "were not stingy with scenario instructions. The approach stage turned out to be most difficult for the crews. At the Cosmonaut Training Center the cosmonauts switch to the manual control of the spacecraft while maneuvering for docking. The 'Bivni' makes it possible to develop Soyuz piloting skills from a distance of 5 km from the station. All the inspectors noted the efficient work of the crews. The understanding between the members of the main, Volkov-Aubakirov crew was irreproachable...."

The examination training session was completed with a mark of "excellent." When they stopped the clock keeping the total operating time of the simulator—space respects record-keeping—it turned out that the "Bivni" had completed that day its 1,000th training session. The drawing of a hairy mammoth adorned the bulletin-board newspaper that was published on that occasion. Its tusks grew sharply upward.

"Would that they had never disappeared and could do cosmonauts some good," Dmitriy Churkin sincerely wished.

But that evening it was clear to everyone that the years of intense work were also not passing without a trace for that ever so reliable piece of equipment. The "Bivni" of Baykonur is getting old. What will succeed it?

Project Involving the Return of Martian Soil Samples Collected by a Mars Rover: A Model for Systematizing Research Results for Large Valleys

917Q0177 Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 25, No 2, Mar-Apr 91 pp 145-151

[Article by N. A. Cabrol, E. A. Grin, O. Dollfus, Laboratory of Geographical Physics, CNRS, France; Laboratory of the Physics of the Solar System, Meudon Observatory, France]

UDC 523.43

[Abstract] Researchers feel that a Mars Sample Return Mission would supplement our limited knowledge of the chemical composition of volcanic rock and lavas on Mars. This paper presents a schematic model for evaluating the productivity of the segments of such a mission. The model includes a sequence of operations performed by the various components of the system sent to the planet. The system is subdivided into various subsystems, each of which performs scientific operations: and orbiter, a system of penetrators, a balloon system, and a lander. The lander includes a rover that controls three types of subsystems: science stations, a mechanism for collecting samples, and a system for delivering the samples to Earth. The researchers suggest that productive landing sites would be an unnamed valley with coordinates of 185-191° long, between -15° lat and -21° lat, and the Mangala Valley. Figures 3.

UDC 531.36

Toward the Stable Control of a Spacecraft With a Flat Turn

917Q0138 Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 55 No 1, Jan-Feb 91 pp 166-168

[Article by S. A. Agafonov, K. B. Alekseyev, and N. V. Nikolayev]

[Abstract] Reorientation of an asymmetrical spacecraft at rest with one flat turn relative to an immobile axis—called the extensive method—produces an advantage in fast response and energy expenditure. Optimal program controls were reported in earlier papers, but the controls were impractical because of their instability. The point of departure for the authors here consists of two systems of coordinates with a common origin in the center of mass of the spacecraft—an inertial system ($X_1X_2X_3$) and a local, body-axes system ($x_1x_2x_3$). The motion of the spacecraft relative to the center of mass is described by Euler equations that, with kinematic equations, represent a total system of equations for solving the problem of controlling the spacecraft with a turn. Since the program translational motion of the craft is unstable in relation to the initial perturbations, flat-turn control must be performed in a closed system. When there is external information on the current angular position and angular velocity of the craft, one can compare the programmed and actual motion to plot the control and develop a stabilization momentum which can be technically implemented and which provides an asymptotically stable programmed motion. It is shown that it is possible in theory to construct an asymptotically stable, closed control system using a flat turn. References 6 (Russian).

Superequilibrium Heating of Surface of Heat-Shielding Tile in Subsonic Jet of Dissociated Air

927Q0022A Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 3, May-Jun 91 pp 144-149

[Article by P. N. Baronets, A. F. Kolesnikov, S. N. Kubarev, I. S. Pershin, A. S. Trukhanov and M. I. Yakushin]

UDC 533.6.011.6:536.24

[Abstract] Research on the catalytic properties of heat-shielding tiles for the Buran orbital ship in a flow of dissociated air revealed that the surface of a tile coating was virtually noncatalytic with respect to reactions of heterogeneous recombination of oxygen and nitrogen atoms. However, the spaceship surface might be inhomogeneous in catalytic properties due to contaminations of the tile coating. In order to clarify this possibility measurements and numerical computations were made of the temperature distributions over the surface of heat-shielding tiles with homogeneous and inhomogeneous catalytic coatings around which there were subsonic flows of dissociated air. The experiments, carried out in a plasmatron, are described in detail. The measurement data were consistent with the computed surface temperature profiles obtained from numerical solution of the Navier-Stokes equations for a chemically nonequilibrium flow of dissociated nitrogen. The results are compared with data from a flight experiment on the American Space Shuttle in orbit with respect to the influence of a discontinuity of catalytic properties of the tile coating on the "superequilibrium" surface temperature jump. A numerical analysis agrees well with the experimental data both for surfaces with homogeneous catalytic properties and for a surface with a discontinuity of catalytic properties. The comparison indicated that at high temperatures and pressures 10^{-2} atm the "standard" coating of a tile has a low catalytic activity with respect to heterogeneous recombination of atoms, which agrees with the data obtained in the plasmatron at pressures 0.1-0.3 atm. Figures 5; references 3: 1 Russian, 2 Western.

Preparations for Meteor-3—TOMS Flight

917Q0171 Moscow PRAVDA (2d edition) in Russian 17 Aug 91 p 2

[Article by PRAVDA special correspondent A. Tarasov under the rubric "Report From the Plesetsk Cosmodrome": "The Level of Cleanliness"; first two paragraphs are PRAVDA introduction]

[Text] **The 30-kilogram American instrument—a TOMS ultraviolet spectrometer—has been flying above the planet on our Meteor-3 satellite for about two days now. In appearance, the event is not a grandiose one, but its participants are calling this launch the most important Soviet-American program since the Soyuz-Apollo mission.**

Not without reason did Dr. Samuel Keller, deputy director of NASA, present to Soviet specialists three very beautiful memorial certificates with pennants made from both of the flags that were in space in that memorable year of 1975.

"The keepsake was ready before our departure from Washington," he explained. "And the question was whether we would have enough courage to print under this glass the launch date—15 August."

That actually seems at times like a meeting point of civilizations. There is a special nuance in the fact that the TOMS (an abbreviation for Total Ozone Mapping Spectrometer) is the first American instrument in history to have been incorporated into the electronic circuitry and the control circuit of a Soviet spacecraft. The intense emotional experiences surrounding the "integrations" of the satellite and the instrument come back to life in the stories of the participants. The participants began with completely different technologies, languages, and customs. The instrument was brought for the first "fitting" from across the ocean to Istra, near Moscow, back last fall, and then it was taken back again in order to let the parties digest the discussions and make numerous alterations to their own pieces.

The Istra affiliate of the All-Union Scientific Research Institute of Electromechanics produces our Meteors. The main upheaval there occurred because of our allies' requirements for environmental protection and cleanliness of operations. First, something new happened that "we never expected." From their side came a very sweet, homely-looking, you could say, but totally uncompromising woman, Iva Abrams, a cleanliness inspector for the Perkins-Elmer company. She held a post that, for us, is completely unimaginable with respect to authority. And what was her conclusion?

"Doctor Samarskiy said that a level of cleanliness of 1 million is possible and we won't protect the TOMS. Intense negotiations began, but a plan of operations emerged. We agreed to 15 minutes in a level of 1 million (that's the number of microscopic dust particles per cubic foot), but got as a result six minutes in a level of 150,000. I want to invite you to our Kennedy Center in order to teach them how you did this."

The Tsiklon launch vehicle also "suffered" in terms of cleanliness. Produced at one time at a combat base that was intended to stand up under field dust and dirt and soldiers' boots and was unassuming and durable, and had placed in orbit the lenses of Meteors and Okeans that had been carefully sealed against dust, the Tsiklon was now intensively modified for clean tents and for a low-dust cowling, and the plant shops and the cosmodrome assembly-and-testing building were reequipped. That greatly "strained" the developers of the rocket, and they're grumbling about it, right?

On the contrary, S. Konyukhov, general designer of the Yuzhnoye Scientific Production Association, is satisfied. Not only with the fact that all the documents and protocols had been signed, but also with the fact that the rocket had finally raced off into sterile space. The standards of the rocket have been raised, as has its readiness to accept the no less cleanliness-loving equipment from France and Sweden in forthcoming programs. All of today's efforts will be rewarded more than once.

Is the new level of cleanliness, perhaps, also the key to real changes in all our affairs as well? Let us continue.

The austere, but at times touchingly sympathetic test-range people cannot, in the end, conceal their military affiliation. There's the sparse way of life, of course, and the rigid framework, but there's also the irreproachably efficient work of the space units and no traces of "perestroyka" laxity. But a crude cleanliness is entirely capable of competing with trench cleanliness, the experts say.

A launch can be observed only with a gas mask at your side—the rocket fuel is chemical, and the mask is in case of an accidental spill. The American team, laughing and taking pictures of each other, walks cheerfully through the tent with chloropecrin, testing the masks for the proper seal. Samuel Keller himself, the tallest of them and the most serious, gives the rubber mask a thorough check. Temporarily everything becomes confused, as in the well-known scene from *Zolotoy telenok (The Little Golden Calf)*.

Then with a bag at his side, the standard gear of a test-range private, the third man at NASA answers questions.

"After Meteor-3, would you like to see another set of common steps into space appear? And if so, what would they be?"

"Very much so. We hope that this launch is not the end of TOMS, but the beginning of future cooperation. I would suggest for the next stage the exchange of a cosmonaut and an astronaut for joint missions on Mir and the Space Shuttle."

"What specialties would be preferable for such an exchange?"

"In my opinion, physicians. But it could also be engineers. At any rate, the convergence of the space programs is inevitable. Space is too expensive a matter to deal with alone. Besides, this is a visible space. Our peoples watch the results of joint activity, evaluate them, and are permeated with trust in each other."

When the sharply pointed pencil of the Tsiklon pierced the clouds with its tip, when the signals for the switch-on of all systems arrived from above, very reassuring words were heard from all sides—from ours and the Americans'. "We drove the other side into the corner with our questions, but they drove us into the corner with their answers. But then that's the way we like to work." "We began as two teams, but arrived at the launch pad as one...." "This team, which didn't pay attention to whether it was day or night, worked more than 24 hours a day...."

Lt Gen Viktor Mikhaylovich Ryumkin, chairman of the State Commission, very tired and very patient, very likable and intelligent, almost not like a general, but a genuine scientist, and as if come back to life from the best images of Grekov's marvelous and sad book "Na ispytaniyakh" [At the Tests], brushed aside this colossal change at the cosmodrome, saying calmly and simply, "Yesterday, men, was the last day of my leave. Today is the first day of my retirement...."

His first launch was in 1956, at Kapustin Yar. And test ranges, test ranges, test ranges. Fortunately, more and more peaceful ones. "Honestly, I always dreamed of leaving in such a fine way...."

NASA Deputy Director Interviewed at Plesetsk Cosmodrome

917Q0170 Moscow IZVESTIYA (Union edition) in Russian 19 Aug 91 p 3

[Interview with NASA Deputy Director Samuel Keller by IZVESTIYA science commentator B. Konovalov at the Plesetsk Cosmodrome; "The USSR and the United States Are Exchanging Astronauts"; first paragraph is IZVESTIYA introduction]

[Text] **While preparations were under way for the launch of the Soviet Tsiklon rocket, which was to put into orbit a Meteor-3 weather satellite with an American instrument for studying the ozone layer around our planet, the opportunity arose at the observation post of the Plesetsk Cosmodrome to talk with NASA Deputy Director Samuel Keller.**

Konovalov: What do you think of the experiment being started aboard the Soviet Meteor-3 satellite?

Keller: This is a very important project. For us, it is valuable that American specialists have been able to work for a lengthy period of time with Soviet specialists. They found a common technical language, and our instrument was successfully integrated into the system of the Soviet satellite. This was a quite complex technical task, because each side had developed its own rigid standards and designs, and they had to be combined. The successful solution of this problem is opening the way for other promising projects.

Konovalov: For a long time, the notion that joint design of any space instruments or systems was undesirable reigned in the United States. At best, the "mating" of finished units was proposed. Is the situation now changing?

Keller: Yes, although more slowly than would be liked. For the present, the restrictions on the dissemination of space technologies remain. But they are gradually diminishing as the political dialog between the USSR and the United States becomes more successful. Now it is up to politicians. Engineers and scientists are ready for closer cooperation. I am certain that we will not have any technical problems.

Konovalov: What feasible joint projects are already under consideration in the immediate future?

Keller: During the meeting of the two presidents—Gorbachev and Bush—an understanding was reached on joint work involving observations from space of the state of the environment and on the possibility of the cosmonauts and astronauts of our countries working on the "others'" spacecraft. Plans call for an American astronaut to work on board the Mir orbital complex, while a Soviet cosmonaut will work on our Shuttle.

We hope that candidates for the forthcoming missions will chosen by the end of this year. Training will take at least a year. Our astronaut will have to go through intensive training in order to speak Russian fluently. I think that most likely a specialist in space medicine will be chosen from the American side for a mission that would take place in the next two years.

A continual exchange of medical data on missions of cosmonauts and astronauts is already taking place between us. That area of cooperation will undoubtedly be intensified. For the American side, the immense amount of experience garnered by Soviet space medicine is of considerable interest.

Konovalov: It has been announced that the United States intends in the future to establish a permanent lunar settlement and to carry out a manned Mars mission. Those are extremely expensive projects. Do you feel that cooperation with the Soviet Union would be useful in the implementation of those projects?

Keller: Certainly. After announcing those projects, U.S. President George Bush went ahead and gave NASA the assignment to study the possibility of international cooperation for their implementation. Unfortunately, we are now having difficulties financing the projects. In the next few years, the appropriated money will be spent for the most part on the development of the permanently manned Freedom orbital station, the first module of which should lift off in 1996. That is why we have not yet

considered the possibility of international cooperation for projects of the next century. But we have to deal with that soon, and we, of course, are interested in cooperation with the Soviet Union.

It is developing quite successfully. We, for example, are coordinating our Mars programs. Cooperation in that area is envisaged.

The U.S. and USSR space programs are being maintained at a good level. They do not coincide. You are developing certain areas that are of interest to us, and vice versa. I look at the future with optimism, and I believe that soon the cooperation of the United States and the USSR in space projects will be of a closer nature. That is in the interests of our two countries and all of mankind.

Ozone Study Project Seen as First Stage in Greater U.S.-Soviet Space Cooperation

917Q0175 Moscow IZVESTIYA in Russian 16 Aug 91 Second Edition pp 1, 2

[Article by IZVESTIYA special correspondent B. Konovalov, from the Plesetsk Cosmodrome: "The Ozone Patrol"; first paragraph is IZVESTIYA introduction]

[Text] **A Soviet weather satellite with a large American instrument has been launched from the Plesetsk Cosmodrome.**

The state of the ozone layer around our planet, which protects everything living from the destructive effect of ultraviolet solar radiation, is arousing greater and greater anxiety among experts.

As a result of the economic activity of man, the emissions of ozone-destroying contaminants—so-called chlorofluorocarbons and halogens—have increased sharply in recent decades in the atmosphere of Earth. According to the estimates of scientists, at present the annual increase in the emissions comes to 4-5 percent. At such a rate, the overall content of ozone may soon decrease by 4-8 percent in the middle latitudes and by 12-15 percent in the polar regions. In the opinion of many scientists, that could become the start of a planetwide ecological catastrophe.

That is why for three years Soviet and American specialists worked side by side in order to carry out a joint project and to install on board the Meteor-3 weather satellite the American TOMS for mapping the state of the ozone layer above our common home—the planet Earth.

On 15 August, a historic event took place. A Tsiklon rocket lifted off from the Plesetsk Cosmodrome and put into space orbit the Meteor-3 satellite, whose scientific equipment includes the American TOMS.

Next year has been declared the International Year of Space. And preparation for it has already begun. The Meteor-3 satellite will operate in orbit at least two years. And all that time, it will send information on the state of the ozone layer above our planet to the USSR and the United States.

In 1985, a spring anomaly in the content of ozone over Antarctica, which received the famous name "ozone hole," was detected. It is in the month of August that the anomaly is most pronounced and that the Meteor-3 will begin its study. Its job is to continually monitor the state of the ozone layer. That will enable the world community to evaluate objectively the threat of its destruction, which could have catastrophic consequences.

"We began the work as two different teams," said V. A. Adasko, project technical supervisor and director of the All-Union Scientific Research Institute of Electromechanics. "But after three years, we have become a single, coordinated collective."

And all the participants in the project sincerely applauded the report that the Soviet satellite had been successfully put into orbit and that all the scientific instruments, including the American instrument, were operating normally.

This is the first major joint space project of scientists of the United States and the USSR since the mission involving the Apollo and Soyuz craft, which was carried out in 1975. This time the cooperation was of a more profound nature. If 16 years ago two independent spacecraft were docked, this time the American instrument was "implanted" in the "body" of the Soviet satellite. The successful start of its mission is affording the prospect of even bolder projects.

At one time at the height of the "Cold War," the first Soviet intercontinental missiles were placed on alert status at the Plesetsk Cosmodrome. Now the times have changed. A unified Soviet-American team worked here, preparing the satellite for the mission.

NASA and the State Committee for Hydrometeorology carried out this project jointly within the framework of an intergovernmental agreement between the USSR and the United States on cooperation in space. Before our eyes the confrontation of the two great powers on the space arena is being replaced by cooperation.

At the Plesetsk Cosmodrome there was good weather on the day of the launch. And just as the deafening roar of the rocket subsided, a light, as they say in Russia, mushroom rain [rain with the sun out] began. That's a good omen. The satellite has a long life ahead, and it will not only work for both our countries, but also obtain knowledge for all mankind.

'Cosmos-2155' Communications Satellite Launched 13 Sep

LD1609160391 Moscow TASS in English 1337 GMT 16 Sep 91

[Text] Moscow September 16 TASS—A regular "Cosmos-2155" artificial earth satellite was launched in the

USSR by means of a "Proton" carrier-rocket on September 13, it was officially announced here today.

It is fitted out with equipment to relay telegraph and telephone information on centimeter frequencies. The sputnik was placed on an orbit, which is close to stationary and has the following parameters: 35,850 kilometers from the earth's surface, inclination to the equator—1.3 degrees, revolution period—23 hours 56 minutes. The sputnik's equipment is functioning normally.

'Foton' Satellite With German, French, Soviet Experiments To Be Launched 4 Oct

LD2809071591 Moscow TASS in English 1041 GMT 27 Sep 91

[By TASS correspondent Vladimir Khrustov]

[Text] Moscow September 27 TASS—Soviet, German and French specialists will fly to the Soviet space center Plesetsk on Friday to participate in a joint space research program.

They will conduct the German Kazima-4, Soviet Kashtan, and French Sidex projects to produce unique materials, using a Soviet Foton satellite to be launched on October 4.

The flight will last two weeks.

Institute Developing Satellite TV Equipment

PM0111131791 Moscow Central Television First Program Network in Russian 1000 GMT 30 Oct 91

[From the "Television News Service" newscast: Report by V. Razinkin]

[Text] [Razinkin] Even a few years ago television antennae like these [video shows satellite dish] were considered a fantastic luxury. Today they are becoming a normal feature in the architecture of our towns and villages. Tests of high tech electronic equipment have been carried out successfully by scientists and specialists at the Gradient All-Union Science and Research Institute in Rostov. Within the framework of conversion they have spent a long time working on production of antenna systems for satellite television. This structure enables you to receive domestic and foreign broadcasting around-the-clock. Europe alone watches up to 50 different foreign channels on satellite television, whereas in our country it is seven or eight. And yet we must admit that, despite the existence of a legal base, the development of satellite television is proceeding slowly in our country because of a whole series of problems. One of the reasons is the high cost of antennae and receivers. Many of the designs drawn up by the Rostov scientists have been recommended for serial production. However, the capacities of the science and production associations in the radio industry are still not great. But this year 1,000 antenna systems for satellite televisions will find a buyer. It only remains to be added that we have to resolve a heap of not just technical but also organizational issues before the precious television signals from space appear on our television screens.

Retrieval of Water Vapor Profile in Upper Stratosphere and Lower Mesosphere by Eclipse-Sensing Method in Absorption Band 2.7 m

917Q0112A Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 1, Jan-Feb 91 (manuscript received 16 Feb 90) pp 3-10

[Article by A. A. Buznikov, O. M. Pokrovskiy and T. F. Pchelova, Main Geophysical Observatory imeni A. I. Voyeykov, Leningrad]

UDC 551.501

[Abstract] The first attempt at retrieving the vertical water vapor profile in the stratosphere and mesosphere was on 21 January 1975, over the Marshall Islands, with the KSS-2 apparatus carried by Salyut-4. Those same data have now been reanalyzed using an alternative inversion method. The researchers investigated factors determining the variability of the vertical profiles of atmospheric spectral transmission for the principal lines in the H_2 absorption band 2.7 μm: (a) distribution of water vapor, aerosol, temperature, and pressure; (b) altitude reference; (c) spectral resolution. The information yield of the eclipse method for sensing water vapor in the stratosphere and lower mesosphere was analyzed. It is shown that variations in atmospheric transparency in the indicated band are determined mainly by water vapor. Sensitivity of the lines to the water vapor content at is calculated for different altitudes. The role of various spectral lines was determined, and a relationship was established between optical measurement data and the H_2O concentration in individual atmospheric layers. A layer-by-layer inversion method was developed for retrieving water vapor profiles. The stability of the method was investigated, and the results of solution of the inverse problem were analyzed. Figures 4, references 6: 3 Russian, 3 Western.

Estimating Volumetric Concentration of Mesospheric Ozone From Data From 'Faza' Remote Radiometer Aboard Salyut-7—Cosmos-1686 Orbital Complex

917Q0112B Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 1, Jan-Feb 91 pp 11-18

[Article by Ye. A. Ustinov and A. V. Shmakov, Atmospheric Physics Institute, USSR Academy of Sciences, Moscow]

UDC 528.813

[Abstract] A method described for determining $O_2(^1\Delta)$ concentration makes it possible to use a simple formula

derived from an examination of the principal reactions responsible for the formation of excited oxygen to determine the altitude profile of the concentration of O_3, $O_2(^1\Sigma)$, $O(^1D)$. On this basis a study was made of the problem of retrieving volume emissivity in a molecular band from observations of brightness of the planetary limb, with allowance for self-absorption in the lines. Correlations are derived which are applicable to retrieval of volume emissivity in the band 1.27 μm of molecular oxygen, which is a product of the photolysis of ozone in the mesosphere and upper stratosphere, which makes it possible to retrieve the volume concentration of ozone molecules. A trial retrieval of oxygen concentration was conducted using the results of measurements of emission in the oxygen band at a wavelength 1.27 μm made with the Faza remote radiometer aboard the Salyut 7—Cosmos-1686 orbital complex. The results are compared with those obtained with the SME satellite, and possible reasons for the discrepancies are examined. Figures 3; references 8: 4 Russian, 4 Western.

Analyses of Radar-Image Contrasts Associated With Ocean Surface Inhomogeneities

917Q0112C Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 1, Jan-Feb 91 (manuscript received 12 Feb 90) pp 19-25

[Article by S. A. Grodskiy, V. N. Kudryavtsev and O. V. Shulgin, Marine Hydrophysics Institute, Ukrainian Academy of Sciences, Sevastopol]

UDC 551.46.0:629.78

[Abstract] The fact that little has been published in the literature on the display of ocean dynamics on radar images of a sea surface prompted the researchers here to attempt to describe and evaluate the efficiency of the display of inhomogeneities of the upper oceanic layer in the spatial structure of the backscattering cross-section of a sea surface (σ). They limited themselves to an analysis of cases of radar-image display of ocean variability on a synoptic scale, which is usually associated with horizontal gradients of current speed, variations in surface temperature, and stratification of layer of the atmosphere at the ocean/atmosphere interface. Wind speed and air temperature fields were assumed to be horizontally uniform. Although ocean and atmospheric parameters are actually interrelated, the researchers chose to examine model parameters in order to evaluate radar response to ocean surface variability only. The two-scale radar model of the ocean surface that was used was that of F. G. Bass and I. M. Fuks (1972). It is shown that radar images may reflect inhomogeneities of water temperature, atmospheric stratification and surface currents. The possible σ variations for each of these cases are evaluated. An analysis of the display of inhomogeneities of the upper layer of the ocean at synoptic scales (about 10-100 km) indicated that shear currents exert no appreciable influence on the radar signal backscattering level. Sea surface temperature inhomogeneities may exert an influence on the radar signal level as a result of a change in water viscosity and stratification of the near-water boundary layer. The relative changes in σ increase with a slackening of the wind and are maximal if the wave number of the ripples falls in the range of the capillary-gravity minimum of phase velocity. Figures 3; references 16: 9 Russian, 7 Western.

Determination of Optical Depths of Atmospheric and Hydrospheric Layers From Space

917Q0112D Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 1, Jan-Feb 91 pp 47-53

[Article by M. M. Kugeyko and I. A. Malevich, Belorussian State University imeni V. I. Lenin, Minsk]

UDC 551.501.8

[Abstract] New possibilities for measuring the optical depths of scattering layers of various optical densities (the atmosphere and hydrosphere) and the profiles of the optical depth values $\Delta\tau_i$ (Δz) in these layers from space are examined. The proposed method does not require use of calibration measurements. The determined optical depths can be used as calibration values for known methods for determining the profiles of optical characteristics. The results of numerical simulation of the method are cited, and its effectiveness is demonstrated. The use of this method to determine the optical depths of the atmosphere as a whole and its components, as well as the hydrosphere, does not complicate the measurement process appreciably, even when spectral measurements of optical depths are being made. The spectral values of the optical depths can be determined virtually simultaneously, which makes it possible to analyze spectral dependencies, because the influence of temporal variability of the medium is excluded. Figures 3; references 9: 7 Russian, 2 Western.

Comparison of Information Content of MSU-E and Airborne Scanner Data Based on Example of Solution of Problems in Remote Sensing of Agricultural Resources

917Q0112E Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 1, Jan-Feb 91 (manuscript received 14 Apr 89) pp 54-63

[Article by A. A. Feoktistov, V. P. Bocharov, G. A. Alferov, A. F. Molchanova and Ye. I. Soldatkin, AIUS-Agroresursy All-Union Scientific Research Center, Moscow]

UDC 528.854

[Abstract] Two sets of data were used in a comparison of measurements made with the MSU-E instrument carried by the Kosmos-1939 satellite and observations made with the SMSS airborne scanner at a flight altitude 10,000 meters over Kherson Oblast and pastures located in Kalmyk ASSR. The size of the image element was

similar in both instruments (43 X 43 m versus 45 X 30 m). Data from the three SMSS channels closest to the MSU-E channels were used in the comparison. A 10-day difference in survey times was not regarded as significant. The procedures for processing each data set are described. Digital maps were constructed which involved consideration of 12 thematic classes (water surface, open soil, hay, perennial grasses, winter wheat in a good condition, etc.). Graphs were plotted representing mean signal strengths for the 12 mentioned classes in signal strength coordinates for corresponding pairs of MSU-E and SMSS channels. All the data indicated a superior performance of the airborne scanner. It is concluded that the possibilities of practical use of MSU-E data in the remote sensing of agricultural resources are limited by the low dynamic range of the signal from agricultural features, especially in the case of dark soils. In order to increase the information yield of MSU-E data it is necessary to ensure a possibility for an independent change in the amplification factors in different channels. Figures 3; references 10: 9 Russian, 1 Western.

Metrological Certification of High-Resolution Multiband Scanner

917Q0112F Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 1, Jan-Feb 91 pp 64-74

[Article by R. D. Mukhamedyarov, A. S. Glushkov, A. S. Mikhaylov and R. Sh. Khisamov]

[Abstract] The makeup and functions of the principal components of the newly developed MSUV high-resolution spectral scanner, an optoelectronic system for multiband radiometric measurements for investigating the Earth's natural resources, are described. The principal technical specifications of the MSUV, which registers spatially matched images of the Earth's surface in eight spectral zones in the visible and IR ranges, are given in a table, for example: angle of view, 16.68°; scan width (from 650 km), 200 km; working spectral range, 0.45-12.5 μm; scanning frequency, 12.8 Hz; diameter of entrance objective, 260 mm; dimensions, 178 x 650 x 965 mm; weight, 290 kg; focal length in spectral zones 1-6, 910.0 mm (in zones 7 and 8, 247.6 and 460.4 mm, respectively); power consumption, 600 W; number of measuring channels, 62. A full-page block diagram of the optical-mechanical module is given and serves as a basis for a detailed discussion of its components, structure and functioning. Specific information is provided on the procedures employed in the metrological certification of already fabricated copies of the MSUV apparatus which have undergone ground testing. It is noted that the instrumentation on the Landsat satellites has better energy and spatial resolution. Figures 5; references 10: 9 Russian, 1 Western.

Model Piecewise Method for Determining Ocean Surface Temperature From UHF Radiometric Measurements From Artificial Earth Satellite

917Q0112G Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 1, Jan-Feb 91 pp 75-83

[Article by B. Z. Petrenko, Radio Engineering and Electronics Institute, USSR Academy of Sciences, Moscow]

UDC 551.521:629.78

[Abstract] A general method was developed for the piecewise linearization of radiation-geophysical models for inverse problems in UHF radiometric sensing of the ocean-atmosphere system. This approach is used for determining ocean surface temperature from measurements of vertically and horizontally polarized radiothermal emissions at wavelengths 0.8, 1.35, 2.25, 4 and 6 cm, with an angle of sighting of the surface 45°. A piecewise approximation of the model was obtained for determining ocean surface temperature from UHF radiometric measurements made with the highly promising Ikar apparatus. An archives of linear inverse operators was created, with the operators selected as a function of the mean climatic ocean surface temperature for a given part of the ocean and the type of a priori information on geophysical parameters available for that part of the ocean. A simulation method was used in comparing the accuracies of estimates of ocean surface temperature from measurements with the Ikar-Delta apparatus for various modifications of the simulation method and the regression processing method. The proposed piecewise method with joint processing of measurements over the land and sea will ensure the best accuracy in estimating ocean surface temperature. The limiting accuracy in determining ocean surface temperature is 0.4-0.6 K. These findings will be applied in the implementation of the Priroda program. Figures 5; references 10: 9 Russian, 1 Western.

Determination of Pasture Conditions in Tropical Zone ('Caribe-Intercosmos-88' Aerospace Experiment)

917Q0112H Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 1, Jan-Feb 91 pp 89-97

[Article by L. N. Vasilyev, D. S. Selifonova, V. V. Badayev and V. Torres, Geography Institute, USSR Academy of Sciences, Moscow; Space Research Institute, USSR Academy of Sciences, Moscow; Animal Husbandry Institute, Havana, Cuba]

UDC 634.4:629.78

[Abstract] The pastures of Cuba were investigated by making measurements from an An-30 aircraft, which carried an MKS-MS spectrometer, and the Mir space station, which carried the closely related MKS-M spectrometer. The multiband MSK-4 camera was also employed. The relative accuracy of measurements was to about 1 percent. This made it possible to develop a method for representing the development of a grassy agrocoenosis of the tropical zone in spectral feature space. It was possible to correlate phase trajectory coordinates and the species of a grass stand and its condition. That required, of course, successive surveys at optimal times: end of dry season, rainy season, end of rainy season, dry season. The results of the photometric

measurements were calibrated with the spectral brightness coefficients obtained with the MKS-MS simultaneously with a multiband photographic survey with the MSK-4 camera. As a result, the phase trajectories of development of different species of grassy vegetation, computed using optical densities, were transformed into a spectral brightness coefficient coordinate system. The effectiveness of combining measurements with different spectral resolution was demonstrated. Further development of the method requires improvement in biogeophysical models of grassy agrocoenoses. Figures 6; references 6: 4 Russian, 2 Western.

Military Dominance of Space Program Described, Laser Weapon Satellite Reportedly Shown to Yeltsin in 1987

927Q0006A Moscow NEZAVISIMAYA GAZETA in Russian 25 Sep 91 p6

[Report by Natalya Dvoynishnikova: "Sovereign Republics Have Not Yet Been Determined. How Can Space-Related Properties Be Divided: The Borders of the Baykonyr Space Vehicle Launching Site Are Somewhere in the Ocean"]

[Text] Aleksandr Radionov, chief of the space unit press service of the Ministry of Defense, said that Kazakhstan has already announced the creation of its own space agency, but the republic government still does not know what this agency's task will be. Similar ministries are being formed in Belorussia and in the Ukraine. Space-related properties are spread out across the country, approximately as follows: three-quarters are located in Russia; one-fifth are in the Ukraine, and as many in the Baltics; one-tenth of space industry locations are in Belorussia; and Uzbekistan has one-fifteenth.

In the opinion of A. Radionov, space-related issues should be left in the hands of the Union president, as is done in the United States and other countries. However, in the United States a law on space has been in effect since 1958, while we have not had a space research program to begin with—its various elements have been governed by resolutions of the USSR Council of Ministers and decisions of the CPSU Central Committee. While Korolev was still alive, the entire ideology of the space program was in one pair of hands—he did have influence, and he was supported by Keldysh; after Korolev's death, the design bureau split. Later, the Ministry of General Machine Building got hold of it.

NEZAVISIMAYA GAZETA: This ministry's programs are almost entirely oriented towards military space applications. After Gorbachev's statement in Reykjavik that the USSR would respond to the SDI program by taking a nontraditional step, it was this ministry that started to develop and make military satellites armed with laser guns. One such killer-satellite was shown to B. Yeltsin when, in his capacity as the chief Moscow communist, he visited a major scientific-production association (NPO) in the capital in 1987. It turned out later that such a laser space tank could not fire while in orbit.

At this time, the Baykonyr Space Vehicle Launching Site is a major scientific center and includes several launch and test complexes; 10,000 people are directly engaged in servicing space equipment, and another 50-60,000 are related to space flights in one way or another. In reality, says A. Radionov, the borders of Baykonyr stretch from Leninsk to Kamchatka and then further on into the Pacific Ocean. It all depends on the launch trajectory of the space vehicle. Command and control tracking system centers are located on the territories of all sovereign republics. A. Radionov believes that the results of peaceful satellite work "have no applications here. There is no demand. " His explanation is that in the past nobody was interested in space photography that could show how many hectares had been sown—after all, the raykom [rayon party committee] secretary had already reported that the sowing was completed.

"In India, for example, when they build industrial facilities, they do all the sensing from space: the composition, structure, and density of the soil. They determine the placement of artesian wells with the help of space. This costs them $50-70 million: Each frame costs $300, and they get about 300,000 frames annually. Calculations show that the system more than pays for itself. This means that the next one will cost less. Here, however, we have booster rockets of the same design that carried Gagarin's Vostok that continue to take space vehicles with other crews into orbit. New booster rockets—the Zenit and Proton—have not gone through the necessary testing yet."

During the development of the Buran-Energiya multiple-use space vehicle, there were many new technologies were discovered that still have no applications, A. Radionov emphasized.

NEZAVISIMAYA GAZETA: First the technical tasks—to develop a space shuttle—were assigned to the Ministry of General Machine Building in the mid-seventies; 10 years later, experts (including many cosmonauts) concluded that this type of space vehicle leads to a dead end for technological development. It looks as if the Buran will never fly again. The ministry will no longer receive billions of rubles for such programs.

Chief of the space unit press service Aleksandr Radionov said that space exploration is very profitable. By the way, the first data about the Chernobyl tragedy was received by the French from space. Had space photographs been available, the catastrophe on the natural gas pipeline near Ufa could have been averted. For this, however, a law on space is needed. It is necessary to identify all potential users and to define precisely what the potential of the space exploration is today. And, of course, it needs to be advertised, so that everybody will know about space exploration and the Philistines will not think that cutting expenditures on space research will immediately put sausage on the table.

Statements by Participants in Moscow Conference on Future of Space Program

927Q0025 Moscow INTERNATIONAL AFFAIRS in English No 6, Jun 91 pp 128-138

[Words in italics as published]

[Text] Last winter Moscow hosted a forum on "Who Needs a Space Industry on Earth: Space and the Future of Our Country and Humanity." The forum continued the security research programme which INTERNATIONAL AFFAIRS is carrying out in collaboration with the Rostov School of Strategies for Socio-Intellectual Enterprise. The order for this work has been placed by

the USSR Ministry of General Machine Building, USSR Ministry of Foreign Affairs, USSR Ministry of Defence, USSR Academy of Sciences, USSR Supreme Soviet Committee for Science and RSFSR State Committee on Defence and State Security. The sponsors are the Alibek innovatory research and production firm, Aksai agroindustrial complex and Soviet Committee on European Security and Cooperation.

We invited representatives of ministries and other government agencies, organisations and firms of the space complex, Union and republican government bodies, diplomats, military men, scientists, businessmen, people active in political parties and social movements to take a look through the prism of space at today's scientific, technological, economic, political, cultural and spiritual problems and the future of our country.

The following conversations, interviews and monologues only concern some of the problems raised by the participants in the resultant discussion. Still, they give a fair idea of the attitude to space.

Your New Business Knows What It Wants

David Hardman, Director of Administration and Finance and Acting Director-General, European Telecommunication Satellite Organisation (Eutelsat)

What I hoped to do in accepting your invitation was to meet a lot of people from your country, and I believe I have achieved that purpose. I really don't know much about your business infrastructure. I found it extremely interesting. My impression is of people who are highly motivated, who are very capable and intelligent and know where they want to go. I hope my participation will be useful for Eutelsat, and I hope Eutelsat will be useful for all your customers who want telecommunications services.

From the things that I heard from many people, they need to develop services quickly. Others feel that it's more important to have long-term strategy with a broader view taking in a much larger territory.

I think it is a matter of strategy. In your country you have to decide the speed at which you want to develop. If you want to develop quickly, then I think the quickest way is to start in a small area and in important economic activity, activity which hopefully will produce hard currency for you. The hard currency can be used in order to obtain the technology that you need.

I think these things are possible given the right kind of approach to management. The fact that the Eutelsat satellites are already in orbit and that their technology on the ground is already well advanced and well established gives possibilities to your people to move quickly as they cooperate with us and to generate the hard currency that you are seeking.

Our Director-General has already been to Moscow to see our Ministry of Posts and Telecommunications. It was decided to make modifications to our new generation of satellites to improve the coverage of your country. So we are firmly convinced that strategically it is a good business for Eutelsat to have the Soviet Union as one of our member countries.

I think it also important to remember that Europe is not simply a commercial gathering, it is an idea. And the more people share that idea, the stronger and better it becomes.

I was asked by one of your journalists why I had come here and whether I thought space had any relevance today. I replied that when I received the information paper in Paris—that's where our headquarters are—I saw at once that the conference is quite different from any other conference I'd been to before. Space is a very clever choice of a theme for your conference because your conference is not simply about space, it's about the Soviet Union, it's about all your people, and it's almost about the meaning of life.

We Appeal to the Patriotism of the Space Industry

Konstantin Borovoi, General Manager, Russian Commodity and Raw Materials Exchange; Chairman, Coordinating Council, Specialised Conference on "Inter-Commodity Exchange and Inter-Bank Information Exchange Systems and Space Communications" within the framework of the social and professional discussion

I would like to begin with the report on our work televised on the 9 p.m. news programme. Some 90 per cent of it was an attempt to demonstrate that our space industry is looking for sponsors, for Western partners. To put it plainly, it suggested that we are ready to do business with anybody except our own people. If that is how matters really stand, the it's very dangerous.

I have here an IZVESTIA ad saying "IBM products for rubles." The ad amounts to announcing that Zelenograd is cluttered up with equipment of Soviet make. It implies that computers made in our country are good for nothing because hundreds of plants manufacture what nobody wants. And it suggests that some time later this huge industry is likely to lay off hundreds of thousands of workers.

The space industry, too, is facing a choice. It is bound to die, to breathe its last very soon unless properly oriented. Its death would affect both military production and defence.

The position of Soviet business on this matter is explicit. We can buy foreign satellites at any moment but what we are really concerned about is the state of our space industry. We are willing to make huge investments in it, and we've got the means. It is a problem which must be solved without delay. If we don't solve it we'll again have to see outside help.

We pin big hopes on the patriotism of our space industry and on common sense. The industry must certainly

renounce unlimited power, must be commercialised. But this wouldn't mean losing it. So let us cooperate. This conference is exploring the possibility of founding a space communications joint-stock company. We do need communication lines. We are prepared to join in projects likely to prove their worth today, tomorrow or ten years from now. This would pay, it would be for rubles, we wouldn't have to borrow. But we want to be met halfway. We are very glad of the signs we see. They are visible, they are there.

Democrats Are Looking for Allies in Space

Alexander Bek, member, Coordinating Council, Association of Young Democrats of Russia; member, Coordinating Council, Democratic Russia movement

International Affairs. What induced you as a politician to participate in this discussion?

A. Bek. There is a twofold reason. Represented here are many independent businessmen, especially from commodity exchanges and banks. As a politician, I'm keen and find it important to ascertain the degree of maturity of these structures, for they underlie the market infrastructure, of society.

Second, I'm keen on that part of the work directly concerning space. Our space industry is closely linked with the military-industrial complex, whose interests are often opposed to the interests I defend. This is an open secret. What I mean is that the complex is a major opponent, and it would be wrong of me not to acquaint myself with it directly. On the other hand, I believe that maturing even in this big complex, particularly its space component, are trends towards conversion, towards commercialising the space industry and switching it from the sphere of defence to civilian fields. The trend may prove positive.

I wanted to see the proportions of the trend, the overall tendency of this group of people, all the more since it includes professionals directly representing interests, not reflecting them in political terms, as is done by, say, the Soyuz group of deputies. And of course, I wanted to see how far, if at all, diverse interests can be correlated. The point is that I'm definitely against the official concept of the Treaty of Union. I support the concept of a symmetric community of sovereign republics. On the other hand, I'm not in a mood to accept disintegration. Let everyone be sovereign in his own home. But I'm well aware of the tremendous economic advantage that everyone gains through integration. Where integration is useful, it could be preserved without detriment to anyone's freedom. The question I'm asking, however, is: How to keep in the process of reform the potential we have? This is quite an important question for me because I must choose a positive programme.

International Affairs. What answer did you get?

A. Bek. My feeling is that the space complex is faced with very serious problems. They are really worrying it but the majority still see a way out in what is called stabilisation, that is, they prefer to backtrack, winding up certain new projects, and to get further appropriations. I'm glad to add, however, that those who want to adapt to the new situation have turned out to be considerably stronger than I had expected. They are looking for new customers and outside sources of funding and searching for new approaches. In other words, I see a real change in thinking. I believe this is largely conditioned by age. Most younger leaders seem ore adaptive. This inspires me with optimism, for it means that time is on our side.

International Affairs. What makes you think so?

A. Bek. Let me begin with my negative conclusions. I mean the frequent emphasis on the primacy of the Union and, accordingly, decisions made by the Union government. Not that I consider the subject taboo but those who touched on it did so with a feeling of awe, such as is aroused by something divine. They seemed to suggest that decisions made at Union level can't be disputed. Besides, I was disappointed at a tendency to keep within the narrow bounds of one's own problems as if there had been no others.

But here is a reason for optimism—just look at the exhibits displayed here. I'm a graduate of the Moscow Institute of Physical Technology and know full well what "mailbox" is (a classified production or research facility): those who work there can never see or learn anything outside their field. The stands here display specimens showing a real aspiration on the part of reputable firms to produce articles of a different type. They still lack customers but I see the vast potential they've built up. The future of these firms will largely depend on whether there are consumers ready to accept what they're offered. Banks and commodity exchanges, for instance, are clearly keen on a common communications systems, an interest linking them with the problem of using space. The manifest willingness of free finance and the space complex to cooperate promises well.

Another welcome sign I see is that such firms are participating in a social and professional forum.

International Affairs. We invited practically all new parties and movements to join in this discussion but you are one of the very few who accepted and are present here. What's the reason for so limited a response?

A. Bek. I would list three reasons for the lack of widespread interest. One of them is irrational. People associate the space industry with what may roughly be described as a triad: military-industrial complex—Union leadership—KGB. To enter into any contact with these entities is to risk one's image and reputation. There is an irrational fear of even venturing near such things. It is made worse by a failure to distinguish between, say, agents' work, the military-industrial complex as a political force and purely professional activity.

Another factor is the extreme tension prevailing today. People are very busy and deeply worried. Many of those

who were invited are in the Russian parliament now, trying to convey their views or to do something.

The third factor is, to a degree, our immaturity. Work with the military-industrial complex requires a definite status. It's an attribute of the ruling party or almost. A party can also be in opposition but also close enough to power, can't it? This is what provides experience. Foreign affairs are a further unquestionable indicator. A party which begins working in good earnest on foreign affairs may be described as mature enough to govern. We still fall somewhat short of this. We lack strength and professional people who could work in this sphere. But this will come yet, as will foreign affairs.

International Affairs. What is your opinion of social and professional forums, which are indicative, by the way, of our entire security research programme?

A. Bek. Your programme is valuable in that it is not politicised. This kind of activity may be useful as a connecting link between professional spheres, society and political activity, that is, between structures seeking power. It involves non-governmental and independent opinion and the need to ensure that political likes or dislikes do not stand in the way of solving professional problems.

In other words, there's a need for reciprocal adaptation, coordination of interests and the formation of negotiation mechanisms inside society.

Do We Need to Arouse a Sense of Space?

Vladimir Shkuratov, assistant professor of psychology at Rostov State University

We have tried to look deep into the cultural aspect of space exploration. Examining in this light the name of our forum, "Who Needs a Space Industry on Earth," we came to the conclusion that besides exploration of terrestrial space, there is a sense of space and space-mindedness. They were represented thousands of years ago. What participants in the forum said, concerned mostly terrestrial matters although nothing is wrong with that. I repeat, however, that the concept of outer space differs from that of inner space.

We live in the industrial era, which has gone beyond the boundaries of the earth and yet is closed to space problems in greater measure than any other era. Is this dangerous? Why trouble space sentiments? Why probe into cultural depths?

A sense of space and space-mindedness are needed for homo sapiens to keep psychophysiologically fit, to remain in his contemporary specific state. For if the trend towards a purely technological attitude to space were to prevail, humanity could realise Tsiolkovsky's dream, losing its contemporary anthropological culture. Yet we technologically minded people and humanitarians apparently don't want this for the time being. We want to exist in our present form.

We discussed development strategies for humanity and singled out three terms. It was suggested that society's ecophobe development strategy be offset by an ecophile strategy. Ecophile strategy makes it possible to renew resources borrowed form nature. Thus nature is spared damage. It is an object of worship. Ecophobe strategy, however, takes a purely practical approach. It regards space as just a vacant lot on which to build a bridgehead.

We came to the conclusion that there exists something of an intermediate strategy which we suggest calling ectopic. It consists in setting aside a kind of national cultural parks free from the negative effects of industrial civilisation, with people existing not because they are pursuing any theoretical aims but because they want to enjoy the benefits of nature unaffected by civilisation. The parks would be mere islets at first but would tend to expand and merge, forming an unbroken area of pure culture free from a technocratic attitude to both inner and outer space.

Even those of our eminent scientists who attended this forum take a perfectly realistic, pragmatic view of the tasks of science whereas contemporary development trends of science and civilisation warrant the use of the terms "postscience" and "postcontemporary." Assuming that a feature of the contemporary era is the community of methods of exploring nature that we have, we must put it on record that the more developed countries are leaving this phase behind. They are trying to go beyond it, beyond the 20th century and the second millennium.

These three strategies are understandably not applied evenly all over the planet. There is a first world, so to speak, which is moving on to pure technologies and energy-saving resources and is characterised by a transition to postscience, a postcontemporary era, a ecophile strategy. There is the third world, which is not prepared to renounce dirty technologies because it is in straitened financial circumstances. Third, there is something in between, a second world, now at a crossroads. This one is ours.

But because the earth is indivisible, all three worlds need common ground. Rationalism alone is not enough. We need to turn to every era of our culture.

Space of Cultures

Andrei Zelinsky, Curator, House Museum of Academician Nikolai Zelinsky; Scientific Director, Noospheric Protection Centre

The round table on "Noospheric Protection" which I chaired was a fruit of work by the teams "Space and World Culture," "Space and the Problem of Stabilising Consciousness" and "Space as One of the Means of Ensuring National and International Security." We approached problems of culture, consciousness and security from a noospheric standpoint. It is this approach that those who are trying to induce the public to face space fail to take.

I think it's the concept advanced by Vladimir Vernadsky that can guide and orientate us in a definite sense. But currently even that concept isn't quite enough. The principal meaning of the concept of noosphere is that the sphere of human life is a product of the activity of man's reason. This activity produces both positive and extremely negative results. Regrettably, the noosphere today is turning into an ecologically critical "technosphere" to such an extent as to threaten life itself. This is a consequence of the inertial paradigms of our consciousness which have given rise to industries we go on steadfastly building up day after day. Unless we change these obsolete paradigms forming part of false systems of values and our universal aspirations, neither privatisation nor nationalisation will help us. Nothing can help us because we are in the presence of a global ecopsychological crisis, not to mention the military crisis in the Gulf, which is becoming a catalyst for man's global crisis.

The question we re discussing is whether we can not only stabilise global and national consciousness but direct its vector towards universal values capable of stopping us in the apocalyptic spiral of reckless consumer progress. What can we oppose to this trend?

We are speaking of space. Space is a highly important factor. We are advancing from the idea of applied space exploration to the concept of space formed by Tsiolkovsky, Vernadsky, Chizhevsky, Korolev—great scientists with whom astronautics is closely associated—and from it to the Christocentric space of our Orthodox culture. Without this there can be neither physical nor spiritual flight.

A model published recently shows the cosmos uniting us all in some way. It is the cosmos of our consciousness, or the space of culture or cultures to be exact, which forms the noospheric information fabric of the planet, the planetary fabric in which we really exist as a social body, a state, and which is home for the time being to all peoples because they still live in their traditional ethnocultural protective environments for all that the pressure of technetronic civilization tends to level them, to equalise them, to destroy them. After all, we who live in one-sixth of the globe are not merely a gathering of Russian-speaking people, as we are often called. We constitute a certain organic community linked together by historical, geopolitical, traditional, spiritual, cultural, religious bonds.

This prompts me to note that, according to some sources, Russian statehood with Moscow as its capital will be 500 years old in 1992. So will the discovery of America by Columbus. The latter anniversary will be duly observed in Seville, Spain, at Expo-92. The Zelinsky Noospheric Protection Centre has been invited to the exhibition as a scientific consultant. We were surprised to learn that in Expo-92 plans the discovery of America is accompanied by the "closure" of Russia, or the Soviet Union to be precise. Our country, which still takes up one-sixth of the planet's dry land, is represented to Tobolsk, as we were told, under the name of "North Seville." Notwithstanding the exhibition's motto, "Era of Discovery," that surrealistic treatment of reality suggests political naivet.

I see a solution in all media and all communication facilities of the global informosphere in which we are already submerged helping preserve humanity's cultures, whose survival can be ensured through this inner space. The Noospheric Centre has considered and partly drawn up such a programme.

Astronautics, while connected with pragmatics, must not disregard these things because we all need spiritual navigation systems. What would happen if the panel of an aircraft were smashed? Destroying the "panel" of culture would result in the spiritual death of nations, in denationalisation. Our great scientists Tsiolkovsky, Chizhevsky, Vernadsky, my late father did all they could—each in his own way—to preserve this state, this people, this culture. We must immediately use all that we've accomplished in space to preserve traditions, culture, the people.

Needed: Priority Goals

International Affairs. For soviet people, the concept of space is something personified. You have only to utter the word for people who have nothing in common with space exploration to recall Sergei Korolev, Yuri Gagarin. Those were leaders. What are the qualities of a leader? Do we now have comparable leaders in our space complex?

Vladimir Karrask, Deputy General Designer, Salyut Design Office, Experimental Machine Building Research and Production Association

Leaders have a sense of the limit of risk and the limit of novelty, for the newer something is, the greater the risk involved. It's like a racing car passing a curve: there is a speed limit at which centrifugal force interferes in friction and pushes hotheads off the track while drivers who are too careful fall behind those having a keener sense of speed.

I worked with outstanding designers: Vladimir Myasishchev, Vladimir Chelomei, Alexei Isayev, Valentin Glushko. I saw Sergei Korolev many times. You know, they were all unique—all of them—but speaking of the totality of their qualities, I must say that each of them met the requirements of his day. Life itself produced such people. It is amazing that despite their dissimilarity, each of them was up to the requirements of his day.

International Affairs. Thus the question is: What are the requirements of today and who are those who can meet them? Can we indicate the juncture at which the era of leaders drew to a close?

Alexei Yakovlev, Deputy director, Machine building Research Institute, Nizhnaya Salda, Sverdlovsk Region

There can't be any "junctures." It's a question of a definite situation, of its trend, its explosiveness, the motive character of processes. In a crucial situation necessitating a very dynamic process, it is the process itself that produces the right people.

Take the fifties and sixties as an example. There cam an explosion of rocket production. Why, all firms and infrastructures (except the Moscow-Kaliningrad complex, which came into being in the forties) were set up between 1958 and 1961. The whole infrastructure was created in three years. I mean the Siberian region (Krasnoyarsk, Omsk), the Urals, the Ukraine. That production explosion occurred in the Soviet Union, and see how many leaders came forward. They appeared unexpectedly all over the country: Yangel, Reshetnev, Pilyugin, Isayev, Glushko. And they pulled the whole technology forward.

When so dynamic a period is over there appears entirely different people. What I mean is that first we get choleric people, then come the sanguine, and lastly the phlegmatic take over.

Professor *Nikolai Melnikov*, Moscow Aviation Institute

Let us see, however, which is primary: time as an independent parameter or as something we create by means of certain mechanisms?

I believe that, basically, there is an elementary thing at work: people create a system, and the system selects, moulds, educates them, somehow generates executors. As I see it, the essential thing in our system is that the system strongly tempts people holding key posts to be amoral. This temptation also existed before but it was not so strong, perhaps because there was also something different, such as a sense of responsibility, possibly stemming from a fear of practical conclusions but going in the opposite direction. We hardly have this in our country any more.

I was shocked when, in my early years as a scientist, I took the initiative of saving an unmanned aircraft. It transpired that the design of the autopilot was wrong. On being separated from the carrier the craft would perish after plunging into dense layers of the atmosphere. Imagine my astonishment when the general designer of the craft flatly refused to correct the design. It was still more amazing that he found allies among his customers from the Defence Ministry. The very system tended to encourage them to adopt an essentially amoral civil stance.

Designers are often placed in a situation where they consider it useful from a purely departmental, selfish pint of view to abandon an imperfect article, to get rid of it as quickly as possible, in order to secure a new contract and more funds. The system induced you to regard the interests of a project and the results you achieved as secondary and to give priority to earning a living and winning prosperity for yourself, your firm and your team. If you weren't gifted enough to finish the job fast and efficiently enough but had a chance to get off with nothing more than a fright although you had bungled it or even to win an award, as in the case of Buran, to which I devoted ten years of my life, then you had better do the bungling on time, get a new contract and begin from the beginning. You started again from scratch and we enabled in effect to safely mark time. This explains why people resisting the temptation to do just that gradually drop out because there seems to be no objective need for them under the system.

A. Yakovlev. We now have no priority goals, that is, goals in which society or at least a government agency has a big stake. And where there are no goals, neither are there people willing to realise them. What we have is a lot of tiny goals, so to speak, and everybody gets his bit of sustenance by fussing about them. This is why an energetic person is pulled back by that inert mass as soon as he turns up.

International Affairs. I suppose it was concern about the state of affairs in your field and all over the country that made you join in so unusual an activity as a social and professional forum. It must have prompted you to seek contacts and cooperation with people traditionally separated from the space complex by various barriers. Did you derive any benefit?

V. Karrask. I was very interested to hear a series of papers and attended a round table on "Space and Ecology." Incidentally, this is the first time in my life that I've taken part in a round table. You probably know, don't you, that those who work in "mailboxes" have no idea of what goes on in the neighbouring room.

I was pleasantly surprised by the wide range of the very interesting technological, economic, social, ideological problems raised here. I'm very glad to have witnessed such pluralism. I heard many very original, completely unusual opinions. I even felt that in forty years of work I had become fixed on certain views, and so I'm now trying to make myself revise them. We are also satisfied with the commercial contacts established.

A. Yakovlev. You were right in saying that one constantly comes across original thinking here, original views on what had seemed to be thoroughly familiar problems. As a specialist doing practical work, I approach every problem from my own angle and form accordingly my philosophical concept of it. But here I am standing face to face with something entirely different, with views belonging in a different class and reflecting a different approach. And frankly speaking, I tell myself that, why, there's something in that.

N. Melnikov. Stewing in our own juice, we are somehow disinclined to assess our effort objectively. Talking about things in our own circle, we colleagues discuss both professional and general topics. I've noticed that people sincerely condemn the Ministry of Water Resources for its readiness to gut any tract of land as long as it was paid for the job. But they never apply the same yardstick to themselves. And they rejoice when they get a contract

that can't benefit society and is bound to cause damage. The result is that we have orders to manufacture rockets, on the one hand, and orders to scrap missiles and tanks.

I feel that discussions like this one help us take ann objective look at ourselves.

Nevertheless, I think even this kind of approach doesn't enable us to go beyond definite bounds. We spoke a lot during our discussion about the chaos tending to undo our effort in the area of astronautics. But we hardly asked ourselves whether it's following the right strategy.

What is being done in space is a fundamentally global matter in which world outlook and ideas must be given priority over technological potentialities. I see one of those ideas in exploring space without using rockets. I mean the idea of creating a vacuum ring around the earth that the centrifugal force of a cargo propelled by means of a powerful electromagnetic field would raise to preset altitude. It would be an only project usable any number of times and could include both laboratories ad facilities for the production of medicines, crystals, and so on, as well as for work in space.

I don't think that would be more fantastic than Tsiolkovsky's ideas seemed to be in his day. It's very important that the task be slightly above our possibilities, that it do not overwhelm people but help them advance as they carry it out. It is something which can't be done without large-scale international cooperation and leaves room also for all those who only think of their own interests.

V. Karrask. The range of problems submitted for discussion and generally covered by the concept of space is so wide and the time at our disposal so limited that what has been going on in these five days may be seen as a prelude to a series of projects that will take years to carry out. I can say with a full sense of responsibility that we are interested in such an initiative and willing to support it to the best of our ability.

Terrestrial Tasks of the Space Industry

Professor *Konstantin Feoktistov*, USSR Cosmonaut Pilot, Bauman Moscow State Technological University

International Affairs. This forum is taking place shortly before the 30th anniversary of the first manned space flight. In the past, Soviet people took pride in their achievements in space but nowadays those who have to do with astronautics aren't exactly in a festive mood, nor does public opinion seem to be looking forward to the anniversary very eagerly. What's the reason?

K. Feoktistov. The main reason is the overall unhappy situation in our country, for it conditions people's attitude to anything. But people lost interest in astronautics even before perestroika, some time in the early eighties. There were no obvious achievements any more. What we had every time was one and the same kind of reporting from a spacecraft about successes that made us all wonder if those were successes or failures.

We developed an instrument enabling us to work in space but that work came to look, or rather looked from the outset, like something done just for show. I suppose the whole thing was natural at first because what matters above all is *who* begins and *who* leaps farthest. With us, however, it became a permanent factor. We strove to win worldwide admiration again and again by, say, launching a new spaceship and then launching two. Afterwards we staged a circus stunt done by three men at the big top: we lifted three spaceships into orbit. Nobody could understand what for.

Astronautics has made great progress. I mean worldwide. With the Americans, for instance, satellite telephone channels number millions whereas we had fewer than 2,000 about a year and a half ago and besides most of them were used by the military. This is laughably little compared with what we could have done long ago. But there is hardly any progress.

It is quite clear that the greatest achievements were scored in the area of communication, meteorological and intelligence satellites, which I think played a positive role. Dependable research satellites, including astrophysical ones, were made by the Americans, the British, the Belgians, the Dutch. He supplied an extraordinary amount of new information, which made it possible to make serious scientific discoveries if not to present a new panorama of the world.

With us, however, things are going from bad to worse. We can't hope for breakthroughs in a situation where confidence has been badly undermined by absurd projects and equally absurd expenditures. The country's plight is such that it is questionable whether we can keep funding to its present level whatever those on top may say, putting a bold face on it. We expect a budget shortfall this year, which means that appropriations for space will be cut.

International Affairs. What do you think of the increasingly popular idea of concentrating on building up a powerful high technology sector to produce export items and help the whole economy?

K. Feoktistov. We are again told in good earnest that we ought to further production of capital goods and develop new technologies rather than working to reconstruct the whole economy. We've been promoting capital goods production for seventy years. Isn't that enough? Are we to rob other sectors once again so as to fund this one? Are the rest to be left with only residual capacities?

Of course, we could concentrate on some sector to achieve a breakthrough. But no amount of concentration makes it possible to achieve high technological standards. They can only be a result of competition.

International Affairs. What about preserving the intellectual potential?

K. Feoktistov. We do, and very pressing ones, too.

First, we need communication and television relay satellites.

Second, we could submit to the UN a proposal to set up a worldwide international system to monitor the earth's surface, the atmosphere, the oceans and even the underwater situation. The resulting information should be fully available to all who pay for it. Humanity needs an objective and open system of monitoring all that occurs on land and water, in the air and under water. An all-weather system with a reasonably high rate of updating information—say, every half hour—with the whole area accessible to observation, with everything open and everybody knowing all that takes place on the other side of the fence, in his neighbour's backyard, and whether a further Saddam Hussein isn't laying plans for aggression. If we were to propose such joint projects, I'm sure they would be in people's interest.

We need an international ecological service operating from space.

It is certainly necessary that orbital stations be manned provided that there are orders for real research up there.

And lastly, we need serious research which we can't cope with by ourselves but in which we could join by providing vehicles and offering our experience of developing spacecraft.

International Affairs. What you are speaking of is international projects. Our participation in them would in all probability require serious reforms in our space complex, specifically a relaxation of our secrecy regulations.

K. Feoktistov. That's no problem at the moment. The way things now stand, contracts would drive the most hard-headed leaders into international arms.

Of course, the West is wary of doing business with us because of the fluidity of our domestic situation, not to mention the fact that commercial interests and competition play a role.

There are things we can offer for sale on the foreign market. We have reliable experimental and testbases that can be used. We are indisputably ahead of others on orbital stations, on crew and cargo delivery vehicles. We can sell rocket launches because they are half or one-third as cheap as in the West. We could take orders for rockets. Besides, customers could order work in orbital stations, could equip them with their own instruments and carry out their own programmes. They could dock their modules to our stations and place with us orders for modules in which to install their equipment. There is no problem—it could be done in a mere year or year and a half. We could cooperate, first proposing joint projects and then deciding on who should do what.

Profitability of Mir Station Operations Questioned

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[Article by Colonel M. Rebrov, science reviewer for KRASNAYA ZVEZDA: "Drag in Space Orbit: Some Thoughts on the Profitability of the Unique Mir Complex"]

[Text] In February of this year, the third-generation Mir orbital station marked its fifth birthday. That fact in itself is no special cause for joy: by space standards, the period is negligible. Instead, something else should be given its due: all these years, a multi-purpose research institute has been in operation in orbit, and in the laboratories of that institute one can conduct space-based programs in ecology, astrophysics, medicine, production, materials science, etc. Five modules can be docked to Mir, and they constitute almost the same volume as the basic unit. And although only three of them have been hooked up in space—Kvant, Kvant-2, and Kristall—that orbital scientific center today already has powerful ultraviolet and X-ray telescopes; the state-of-the-art MKF-6MA camera; an attached platform with scientific instruments capable of pointing at any object under study regardless of the attitude of the station; the biological Inkubator complex; a number of unique units for the manufacture of semiconductors; and the Aynur complex for electrophoretic purification of protein preparations that go into the preparation of vaccines and serums.

We will add the Marina and Glazar telescopes, spectrometers, analyzers, injectors, a flying chair (a "space motorcycle"), and other permanent and replaceable equipment—gear which makes it possible to conduct various studies and experiments.

With all due respect to the American space shuttle program, I must note that a weeklong shuttle stay in orbit (and in the future, as long as a month) cannot compare in any way to a long-duration, permanently operating laboratory. And it is no accident that the American company "Payload Systems" had expressed great interest in conducting a series of biotechnology experiments on Mir.

In point of fact, our "space mooring facility" could also become a site for mooring, refuelling, etc. for shuttles and aerospace planes like the Western European Hermes, the English Hotol, and the German Sanger. Their stays in space are limited, but they could lift scientific equipment into orbit for long-duration work and return the results of experiments and studies to Earth. Here's another thought: the Americans, who are far ahead us in space business and who know how to count dollar costs and dollar profits, are developing their own space station Freedom. Why? To "make money from space." In a word, the competitors are wide awake!

Much good can be said about Mir. The design is good, and its incarnation in metal has, in general, succeeded, and the prospects for such space complexes is uncontested. Mir is the embodiment of much "know-how" (we should go commercial with that!), and many examples could be given of the efficiency of the solution of individual design and engineering problems (the station has special power gyroscopes for attitude control which make it possible to decrease operation costs by 80 million rubles (R).

In past years, dozens of Progress cargo craft have docked with Mir, and about 100 tons of cargo have been delivered into orbit (that is about five times more than the initial launch mass of the station itself). There have been nine main missions (with durations of five, six, and 10 months, and even a year), several visiting missions (including international missions)—all of that is to Mir's credit. People working in space have performed thousands upon thousands of observation sessions and photograph surveys and have conducted hundreds and hundreds of experiments. There has been an avalanche of information from orbit, and much material has been gathered which requires processing, and of course, transfer (!). But....

That very "but" persists in everything that concerns the profitability of Mir or a cost-accounting approach to work on Mir. There are a few more things I'd like to say after yet another international flight has been made. Anyway, never mind the international flights—all is not well here at home.

Take the planning of future experiments. Everyone agrees that preference should be given to work which focuses on the solution of specific economic problems. And that criterion is considered especially determinative in competitive selection of experiments for installation on Mir. But there is almost no such competition.

I repeat, Mir and its modules constitute a great scientific and technical achievement. But in our times, neither space construction nor any of the space flights can be ends in themselves. That is also true of the improvement and augmentation of the station. Improvement for the sake of improvement is absurd. But the question arises as to why a family of, for the most part, only two people lives in that "multi-apartment stellar home." Can those two people promptly and adequately satisfy the demands of hundreds of scientific and production organizations?

Today the space watch is being kept by the ninth main long-duration mission, and the first data on the economic effectiveness of manned flights didn't appear in the open press until after the fifth was completed. When the "Secret" stamp was removed, we found out that spending on the fifth mission amounted to R90 million and that it was completely recovered by the profits from the sale of the results of the production experiments and earth-resources surveys.

The sixth mission, according to the plans, was estimated to cost R80 million, and the revenues would be R105 million. In other words, R25 million is pure profit.

The seventh and eighth missions were avoided in information and commentaries on the bottom. We only know that Mir does not have enough electric energy, and for that reason, the program of production experiments (more accurately, the semiindustrial production of crystals) was only partially completed. In addition, some of the specimens which were delivered from the station by the visiting missions were found to have been destroyed. And it was quietly announced that the recovery capsule of the new Progress (Progress-M) did not reach the intended landing site "for technical reasons" (to put it simply, there was an accident). But, look, all of that is money. American experts feel that if things are set up properly, in the near future the volume of sales in the space technology market could reach $10-16 billion. Let's not give our share away.

In recent times, we have said much about the need to change our approaches to our very thinking about everything concerning the creation and use of space equipment. In particular, we are talking about a change in priorities. It's not a simple matter. But then, you cannot hide from it. Flights of foreign cosmonauts on Soviet craft "on a gratuitous basis" and experiments performed on Mir "without mutual monetary consideratiions" are, at the very least, uneconomical, and are criminal if one considers the grave economic situation in the country. The rich Americans ask $25 million for each flight of a foreign astronaut on the shuttle. And they get it!

Let me express my personal opinion about "selling" space in our spacecraft to anybody who pays. Delivering advertising specialists or simply thrill-seekers to the scientific (!) orbital complex does not do us great honor, for the tinsel of "prestige" is no real beauty.

The guaranteed lifetime of Mir runs out in 1992. Will the station's designers succeed in outfitting the station with two more modules, and if they do, will we be able to squeeze out of them everything of which they are capable—will we make them highly profitable?

Questions, questions, questions...

And they are not idle questions at all. Space is not a goal in and of itself. More than 1,000 of the country's organizations, belonging to 22 ministries and departments, use today's space-derived earth-resources information in just the USSR alone. Soviet photographs of the Earth's surface are disseminated through an American intermediary firm to the US and other foreign countries. The testing of the Austrian Reflotron instrument is worth something, after all, the flight of an Austrian cosmonaut lies ahead...

Here are some other figures. The British will pay us for the flight of their cosmonaut (according to unofficial information) 15 times less (a total of 1.7 million) than it would cost the United Kingdom to fly on the American

space shuttle. But that is a drop in the ocean of missed opportunities. The shortage of electrical energy on Mir means more serious losses. I could be accused of presenting boring figures. But we are talking about money that is being taken out of our pockets. It is likely that if we were to use the place of the "third man in the cabin" for ferrying back and forth, shall we say, a "commercial cargo," we could reap a big profit.

In a word, there are many doubts, but I'd like to believe that things will get better. It is possible. But the worst things for use would be to stall in space orbit.

General Ivanov Interviewed on Space Spending, Importance of Military Space

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[Interview with Col Gen Vladimir Leontyevich Ivanov, chief of the USSR Ministry of Defense's Space Units and candidate of technical sciences, by Col A. Radionov, KOMMUNIST VOORUZHENNYKH SIL stringer: "Space Exploration: Stars and Thorns"; first paragraph is biographical sketch of Ivanov; second and third paragraphs are source introduction]

[Text] **Vladimir Leontyevich Ivanov has been in the Armed Forces since 1954. He graduated from the Caspian Higher Naval School imeni S.M. Kirov, the Rostov Higher Command and Engineering School imeni Chief Marshal of Artillery M. I. Nedelin, and the Military Academy imeni F. E. Dzerzhinskiy. He has been a crew chief, a section chief, and a group chief, as well as missile regiment commander, a division commander, deputy commander of a missle army, and commander of the Plesetsk Cosmodrome. From the position of executive officer of space units of the USSR Ministry of Defense, he was appointed in 1989 as chief of those units. He is a candidate of technical sciences.**

Thirty years ago, on 12 April 1961, the news resounded throughout the entire world: A Man Is in Space! A citizen of the USSR and a major in the Soviet Armed Forces, Yuriy Alekseyevich Gagarin, became the first earthling to get a look at our planet from the altitude of a space flight. Over the past three decades, our domestic space program has overcome quite a few difficulties, incurring heavy losses at times, and has made great strides foward in the study and exploration of the universe. It has become an integral part of the national economic system and an important link in ensuring the country's defense capability.

Colonel A. Radionov, our freelance correspondent, talked with Col Gen V. Ivanov, chief of the Space Units of the USSR Ministry of Defense, about the problems of today's space program.

Radionov: Vladimir Leontyevich, recently, the problems in the further development of the space program have become an object of interest to many people—scientists, statesmen and public figures and even those who seemingly have nothing to do with space. Some are fighting for an intensification of efforts in this field, others are sharply criticizing our space programs, while yet others are insisting on curtailment of certain areas of space research. In your opinion, what is the reason for such agitation of public opinion and such discord?

Ivanov: First of all, I would say that our space program needs neither justification nor defense. It has existed for four decades, has permeated, in essence, all fields of human endeavor and is an object of national pride. Almost the only one we have today.... The levels and directions of its development have long since gone beyond the limits of the early predictions.

This unique sphere of human endeavor is opening up ever newer horizons of scientific and technical progress, without which further development of the economy and basic research is unthinkable. At the same time, the space program requires very sizable expenditures, but our shrinking budget is making it necessary to count each ruble [R]. And so, the thoughts arise in some minds: "reduce," "squeeze"! They are passed off as an attempt to look after the well-being of the people, without deigning to delve deeply into the problem. Here, as nowhere else perhaps, it is appropriate to recall the saying: "penny wise and pound foolish." By economizing today on space research, we may incur unforeseeable losses in the future, not to mention having to make up continually for lagging far behind the West in a number of sectors of science and, what is most important, in manufacturing processes. Those who understand this are "for" increasing our efforts in the exploration of space, while those who do not, are "against"....

Radionov: Yet, all the same, the raising of the question of the appropriateness of large capital investments in the space program, under the conditions of the strained state budget and the unsettled nature of the many social problems, is natural enough for the broad masses who want to improve their well-being not sometime in the vague future, but now, in the immediate future. How are people to be convinced that it is not worthwhile to emulate that penny-wise person?

Ivanov: First, let us examine how this problem is handled abroad. Indeed, it is no secret that, if in the sixties, space activities were the prerogative of certain states only and symbolized belonging to the great powers, today, they are a social and economic necessity for many countries, including developing countries.

For example, a space program could have helped Thailand avoid the ecological catastrophe associated with the intensive clearing of the forests. Indonesia, situated on islands stretched out along the equator for thousands of kilometers, is considering satellite communications as the sole, economically acceptable system for nationwide communications. Kenya is using space meteorology for predicting hurricanes. It heads the African Council for Remote Sensing of the Earth. And that, even though the

country does not possess its own space technology, but either purchases or rents it from the United States or France. So it is worthwhile.

The experience of foreign states shows that, even today, we can rely on our domestic space program as a highly profitable sector of the national economy.

Let us take, for example, space-based meteorology. Every 90 minutes, one space vehicle gathers a hundred times more information than 1,500 ground weather stations. According to the estimates of UN experts, reliable prediction of weather two weeks in advance can provide an annual savings on the scale of the worldwide economy of around $9 billion. For our country, this sum amounts to R600-700 million per year.

Unfortunately, we do not as yet have a clear-cut method for calculating the efficiency of space research. Nevertheless, it is possible to cite several quite specific figures. For example, in June of last year, the Kristall manufacturing module docked with the Mir complex and soon thereafter the Krater and Zona furnaces began operating, and already, in the brief period of time since, the economic gains from obtaining materials in zero gravity have amounted to around R7.4 million. The new, high-efficiency photographic equipment placed into service on the Soyuz TM-9/Mir/Progress M-3 orbital complex—the KFA-1000 and the KAP-350, with its splendid ground resolution—makes it possible for our departments to enter the world market with competitive products. And that means a considerable amount of income. The economic gains associated with a mission in the field of geophysics and space photography have amounted to around R23 million; in the field of astrophysics, R11 million; in the field of medicine, around half a million; in the field of engineering, R20 million, and so on. I would emphasize that those are the figures for just a single mission.

Undoubtedly, space is of great importance for strengthening the connection between the goals of our scientific, technical, commercial, defense and foreign policies. Unfortunately, not everyone understands that....

Radionov: But what's the problem? Could it be that faith in space exploration has really been lost in the land of its birth?

Ivanov: I believe there are several reasons. And first and foremost is the fact that the people have not been kept properly informed. There is no glasnost, and that situation in our country is just beginning to improve. Well-known are the names not only of former designers of space hardware, but also of current designers, and we know where it is being produced and how much. But, for some reason, we do not know or do not want to know that the economic gains from the integrated study of the earth's environment from space can amount to R350 million per year. Among the large number of "revenue items," in addition to the ones mentioned, there is the highly precise cataloging of arable lands, pastures and large tracts of forests, as well as the prediction of the intensity of floodwater inundations and the crop yields.

Abroad, for example, they know that the accurate prediction of the worldwide harvest of crops, which is made with space photography, makes it possible for American businessmen to obtain annual profits of up to $300 million just through the manipulation of prices in the international market. They know there that the cost of a single space photograph encompassing 185 square kilometers of the earth's surface in a stereoscopic image, exceeds $4,000 in the international market. They also know that the capacity of a single space vehicle amounts to more than 30,000 images per year.

That is the way it is among U.S. and French entrepreneurs. We are just starting out on the path of entrepreneurship. At the present time, space photography materials are being used by more than 800 organizations of the USSR Academy of Sciences and sectors of the national economy. With wise management, the impact here, as the calculations indicated, could amount to R1 billion per year. All those things are facts of life, and it would be a serious error to ignore them.

That also pertains to an equal degree to space communications hardware. Its contribution to the state treasury for the years 1986-1990 amounted to R2.6 billion and, in the next five years, will amount to R4.1 billion.

Foreign states are seriously interested in collaboration in that area of operations. A number of contracts have been signed with U.S. and French companies that will conduct experiments involving the growth of various compounds in space on our space facilities. Under the conditions of rigid competition, entry into the international market does not come easily. But traversing that path is extremely necessary. Especially now, when we are attempting to set up the principles of market relations throughout the country as a whole.

Needed here, in my opinion, are not just enterprising people and serious business advertising. Whether we want it or not, there must be a competitive basis underlying aspects of the development of space hardware, and there must be strict regulation of the profit margins for specific work. And we must prepare for this.

Radionov: Which is to say that the market is exerting an influence on the space program. But what is the attitude of the military toward a market economy?

Ivanov: Military specialists are participating in the development of many national-economy space projects and systems. For example, the launches of all satellites in our country are carried out mainly by military personnel. They also control in orbit such far-from-military satellites as Molniya and Gorizont (communications), Tsikada (navigation), Meteor and Resurs (meteorology and remote sensing of the earth), and all scientific satellites and Intercosmos-series satellites. People in uniform provide support for the launch and control of all manned flights.

That, you will agree, is highly crucial and highly skilled work, and, accordingly, it should be paid for by those organizations for whom the satellites are launched and controlled and by the individual consumers of space products. However, it need not be in rubles or dollars. Perhaps it could be paid for through the construction of cultural and communal projects and housing at the cosmodromes or the control stations. Undoubtedly, there may also be other forms of valuations for our labor. But we absolutely must be paid for our labor. And here is why. Having established businesslike relations with the consumers of space products, we, on the one hand, are getting to know the value of our own hard military labor and we are finding specific proprietors for specific types of products; on the other hand, the chain of "demand—supply—quality—responsibility" is beginning to function. That is precisely what we do not have enough of today.

Radionov: Along with national-economy-related space, there is also still purely military space...

Ivanov: Of course. Today, the military space program includes global high-precision navigation, special communications and reliable troop command and control, all-weather operational reconnaissance and warning against a nuclear missile attack, observation of the development of crisis situations and the fulfillment of treaty obligations. In essence, complete monitoring of conditions throughout the world. On the one hand, the space program contributes to the strengthening of strategic stability and measures for building confidence between peoples and, on the other hand, ensures enhancement of the troops' combat capabilities by a factor of 1.5-2. And as the Americans maintain, they are able to do this today. An example are the operations in Iraq.

Radionov: But how?

Ivanov: Take, for example, reconnaissance. Located in an orbit with an altitude of 300-plus kilometers, satellites are capable of detecting ground objects 10-15 centimeters across. Satellites can "see" both a soccer ball on a playing field and a submerged submarine. If need be, photographs of individual objects can be delivered to the office of the President of the United States an hour after they are taken.

Reconnaissance materials are used to generate digital ground maps which make up the basis for flight tasking for strategic weapons systems, in particular cruise missiles, thereby ensuring a guaranteed hit against a target with a deviation of no more than 10 meters.

Their high-precision guidance is provided by Navstar navigation satellites. Demonstrated during the flight tests of that system was the possibility of blind refueling of aircraft in the air, nighttime airborne assault, and pin-point bombing with an accuracy of 9-15 meters.

Such precision, as the American specialists' calculations indicate, can ensure in individual instances an increase by several factors of the efficiency of operations for airborne landing of troops, artillery strikes and direct air support and can also lead to a reduction in the number of aircraft sorties and the expenditure of ammunition during the performance of a whole series of tasks.

The results of radar and electronic reconnaissance are the basis for the measures for refining the penetration routes for strategic air units, plans for jamming the air defense systems of a likely enemy and the organization of electronic countermeasures. The entire aggregate of capabilities of military space are finding application in the development of expert systems and computer models of possible scenarios for conducting combat operations.

[Boxed item: According U.S. Secretary of Defense R. Cheney, the price of the newest strategic bomber, the B2, is between $500 million and $600 million. The cost of a Lacrosse radar reconnaissance satellite is $500 million. Each Trident nuclear submarine costs the American taxpayers $1.5 billion, while the orbital stage of the Space Shuttle costs up to $2 billion. At the same time, the cost of the launch and landing complex for that craft at Vandenberg Air Force Base amounts to $3.3 billion.]

Radionov: All that is impressive, of course. Have those capabilities been confirmed in practice?

Ivanov: Even today, many theoretical calculations are being confirmed by specific results. For example, the events in Lebanon have shown that, guided by the space reconnaissance materials, the coordinates of the Lebanese forces' field artillery batteries had been determined by the American specialists accurately to within 13 meters, which exceeds the accuracy of target grid referencing using other means by a factor of nearly 3.

Let us take another, more recent example. As is well known, during the Iraq-Kuwait events, the movement, deployment and operations of U.S. troops in the Persian Gulf area were carried out with the active support of space-based systems. In particular, space navigation "was enlisted" to guide combat vessels and ships, reconnaissance was used to clarify the situation in the combat operations area, and space communications were used to direct the troops in their operational deployment regions.

This is what Col Jackson Moss, deputy chief of staff of the U.S. Army's 18th Airborne Division and a direct participant in the events in the Persian Gulf, had to say about communicating via satellites: "...within five minutes after landing on the territory of Saudi Arabia, each paratrooper is able to establish communication with the commander of any unit, whether he is in the United States or the neighboring foxhole...."

The truth of that statement has been confirmed by Admiral Watkins who held the position of Chairman of the Joint Chiefs of Staff of the U.S. Armed Forces during the events in Lebanon and who could personally (irrespective of time of day and location) coordinate the

operations of the marines located in foxholes in the vicinity of the Beirut airport.

Is that not, in fact, proof of the significance of military space?

Radionov: From what you have recounted, the readers may get the idea that the space program is a "militarized" sphere....

Ivanov: I beg to differ with you. And this is why. Today, as never before, we need peace. We are standing firmly on the path of positive changes and subsequent arms reduction and the strengthening of confidence-building measures and strategic stability. Questions have been raised about a balanced, equivalent, mutual reduction of nuclear arsenals right down to their complete elimination, with a simultaneous blocking off of the arms race in other directions. And whether we like it or not, the space program has a very direct bearing on that process. It provides complete, impartial information about the state and direction of development of the economic systems of individual states and about construction and troop equipment levels, it provides a basis for talking about the absence of aggressive intentions of those states, and it facilitates the removal of the syndrome of prejudice between peoples and the reaching of mutually acceptable decisions on the problems of war and peace.

Radionov: Is there not the threat of our space program falling behind?

Ivanov: Today, our space hardware is on the level of world-class achievements. And the statements which have cropped up recently about the need to curtail individual space programs sound extremely frivolous. The question, obviously, needs to be put differently: How can we achieve greater profitability for the space program and the vigorous introduction of original technical designs and new manufacturing processes into non-space sectors of industry, and how can we achieve the stable entry of our domestic space program into the international market?

In the United States, those questions are being solved by means of centralized coordination and strict accountability of all institutions and departments participating in the space program to the U.S. National Space Council.

The Americans long ago learned to count "space money." Firm fees have been established for practically all types of services. However, we are just beginning to learn those "fine points." And it must be said, not at the best of times for our country.

The need to draw up a law on space activities is pressing. Many questions can be solved considerably faster if we lay down the principles for the establishment of a single statewide structure for interdepartmental ties, avoid duplication and establish a common price-setting mechanism for the development and establishement of standardized space hardware. This is where a statewide policy in the field of space should be drawn up and the potential markets and procedures for selling space hardware within the country and abroad should be defined more precisely.

This question is waiting for a unique solution. We have to solve it. I would hope that we will not be too late.

Deputy Minister Koptev on Soviet Difficulties in Entering Commercial Space Markets

917Q0169 Moscow DELOVOY MIR in Russian No 151, 9 Jul 91 p 4

[Commentary by USSR Deputy Minister of General Machine Building Yuriy Koptev, as told to Aleksandr Polikarpov: "The Cold Summer of the 39th"; first two paragraphs are DELOVOY MIR introduction]

[Text] **The world press continues its lively commentary on the results of the 39th International Aerospace Show, which was held in Le Bourget, a suburb of the French capital. And the Soviet Union's participation in it, of course, did not go unnoticed. But what aroused a great deal of attention was, perhaps, not so much our exhibit as the composition of the Soviet delegation, which was unprecedented in its representation—nearly all the general and first designers of domestic aircraft and rocket-space hardware. Western commentators linked their appearance at Le Bourget with the Soviet's attempt to break into the existing market of aerospace services and technologies. In the opinion of a number of information agencies, the new Soviet initiative got a cool reception.**

Is that so? USSR Deputy Minister of General Machine Building Yuriy Koptev tells about the goals and results of our country's participation in the work of the show.

Koptev: Our participation was not merely anticipating some commercial activity. First of all, we were striving to confirm our reputation as a leading aviation and space power. We succeeded in accomplishing that task. Our hardware, particularly the orbital complex, was a success with specialists and enjoyed attention from the first to the last day of the exhibition.

And then there was the establishment of direct personal contacts with foreign partners. Prior to that, we were acquainted with them through publications only. But, as we have become convinced, serious modern business is possible only on the basis of trust and, thus, a thorough knowledge of each other.

So in that regard, we can also speak of having made certain gains.

The commercial results could probably have been more impressive than the $10 million contract of Aviaeksport and the preliminary deals that were made by the Ministry of General Machine Building with the Germans and Italians for a total of about $1.5 million. Several factors came into play.

First, the fact that no one wants the appearance on the world market of a powerful competitor in the person of

the Soviet Union. Therefore, they are hindering us in the development of trade relations by all possible means, both decent and not very decent. For example, when discussing the question of the building of a spaceport in Australia they cite the possible leak of technical secrets to the USSR, although not a single specialist of ours will be there. Our participation is limited to just the delivery of the launch vehicle. The attempts at cooperation with Third World countries are coming up against the accusations that the Soviet Union is transferring technologies of dual application and is striving thereby to produce a new Iraq. Although, as is known, it was just such technologies—Western ones—that helped that same Iraq to develop chemical weapons. I am not alluding to the political, obviously far-fetched pretexts that prohibit foreign firms from developing relations with Soviet partners. The discriminatory COCOM lists, after all, still exist to this day, in spite of the monitoring mechanism proposed by us, which rules out the use of Western know-how for military purposes.

Even projects in which the Soviet Union's participation would make them more reliable and less expensive are running up against political obstacles. For example, the American Irridium project for the development of a global communications system. A total of 77 satellites placed into orbit would enable anyone at any spot on the planet to pick up the telephone and talk to any one else who has a telephone, no matter where he is. A necessary condition for the reliable operation of Irridium is that the coordinates of the satellites be precisely fixed. Our delivery vehicles guarantee that that condition can be met. The developing firm does not object to their use. The U.S. government is blocking the possibility of such cooperation.

Second, we are absolutely ignorant of the workings of the world aerospace market and for that reason often make fools of ourselves, making mistakes both in commercial strategy and in elementary matters involving the conclusion of contracts. In order to correct the situation, a memorandum was signed during the show on the establishment of a joint Soviet-French joint-stock company that will concern itself with the promotion in the West of our scientific and technical developments.

Our main trump card is delivery vehicles. In all parameters—and this is universally acknowledged—they surpass American- and European-made vehicles. But even here, unfortunately, not everything is going swimmingly. The demand for launches is not that great—according to the most optimistic predictions, between now and the year 2000, no more than 200 of them will take place. And 54 percent of the orders for launching payloads are in the order book of the European Arianespace company. And that, even though a launch with them costs $120 million, while a launch with us costs half as much. We took too long to find the heart to reveal to the world community domestic space "secrets." But in business, as is known, lost time is lost money.

Interesting proposals from Asian countries that have enjoyed an economic spurt have now been made to us. In particular, the Republic of Korea would like to obtain technical assistance from the USSR in the development of its own satellite, and talks are under way with China on reciprocal participation in national space programs.

The conclusion that can be drawn from everything seen and heard at the show at Le Bourget is, in my opinion, the following: We should give up our customary megalomania in international business relations—selling then and there, for example, a Proton and launching nothing less than a 100-ton machine. It is more intelligent to pay more attention to comprehensive programs—programs, for example, that involve the development of information systems, where the launch itself is not the ultimate goal, but a component of the project—and striving to reduce the cost of the project, a firm studies possible proposals, and we have a chance to be chosen.

And, in general, it is not worth ignoring any of the versions, when the prospect is afforded of taking care of our interests, of course, within the framework of international understandings. Obviously, no one else is going to worry for us about our revenues.

Feoktistov Discusses Space Program Goals, Urges Privatization

917Q172 Moscow ZNANIYE-SILA in Russian No 4, Apr 91 pp 20-25

[Interview with Konstantin Petrovich Feoktistov, by ZNANIYE-SILA correspondent G. Vershubskiy, under the rubric "Conversations About Technical Progress": "For We Make Rockets"; first pargraph is lead-in to interview]

[Text] In the 30 years since Gagarin's flight, many names have been written into the history of the space program. Among them is Konstantin Petrovich Feoktistov. A well-known designer and cosmonaut, he could tell us many interesting things about the achievements of his colleagues. But we're interested in something else. We'll begin the interview with Feoktistov with the following question:

Vershubskiy: Should we be going into space right now, with the current situation in the country? Should we be expending so much effort and so much money on space? In what we now call the time of stagnation, we could afford to do such things. But can we afford it now?

Feoktistov: It wasn't until only relatively recently that our semi-destitute existence balanced somehow, although life was rigorous, unjust and degrading. The totalitarian government made ends meet by paying everyone—including the functionaries—little. And then there were controls that saw to it that no extra money was printed.

Our economy was never very strong, but we thought it was necessary to increase our military muscle, and we allowed ourselves the luxury of portraying ourselves as a leading power.

In the space program it wasn't so hard in the beginning, we managed to get by without spending too much money, because we were dealing with item-by-item production. Individual rockets, individual spacecraft.

Then it happened that when we were conceiving Vostok, we got the idea of making it in the shape of a sphere. That design, it seemed, would be very good. But new dies had to be made, and we were pressed for time and hurried. The workers had to knock out the models by hand. With everything home-made, why shouldn't we move ahead if we had our wits about us and loved our work? That's why the space programs did not cost too much.

Now the situation is much worse. First of all, today's technologies require large expenditures. Second, in a transition period in which the economy is, to put it mildly, limping on both legs, all it takes is for several factories to not meet their targets, and production in the entire branch collapses. Then there's just not enough money. Especially when it is squandered on useless projects like Buran, on which more than 15 billion rubles [R] have been spent, and we are continuing in that vein, diverting hundreds of thousands of people from the production of goods that the people need.

Vershubskiy: Those closely linked with the Buran program say that it has given much to the economy. The technical and technological innovations alone that are suitable for consumer production are numbered in the dozens. And, they say, even if nothing comes of the spacecraft itself, the colossal spinoffs in scientific and technical progress will pay back all that has been spent many times over.

Feoktistov: Have they told you where those "innovations that benefit industry" are being used? I don't know where any are being used.

Lets face the truth. Our Buran was born of the notorious desire to "catch up to and pass America." We did not notice or want to notice that the American space generals were also bluffing when they talked about the "technical leap" gained by industry as a result of the execution of the lunar program or the shuttle.

On July 21, 1969, we all looked at the Moon with unusual feelings that were new to us. It shone brightly in the sky as it always has, that orb so lauded by the poets. But now people were walking around on it—Armstrong and Aldrin.

People's perception of themselves—both believers and atheists—stimulates them to seek new things and to expand the sphere of their understanding, their actions, and their lives. It is true that that frequently manifests itself in a purely geometric sense: the distance of the journey, the height of the television tower, the biggest cannon, the biggest bell, the biggest rocket. That's the usual psychological statement, although it is logically unconvincing: by moving the boundaries of achievement, we get the opportunity to learn more about the world and, possibly, about our place in it and about ourselves. For the majority of people, that statement was the motive force for the lunar project.

The euphoria of the project designers and, most probably, the majority of Americans then was understandable and natural: "We are on the Moon and not those Russians, vegetating in their dogma and hierarchical structures. It was little more than a miracle that they managed to temporarily capture the lead in space and launch the first satellite and send Gagarin into space. Now, finally, everything's back in place. Our prestige has been reestablished!"

That is how the implementation of the lunar project began. Over three successive years, the Americans landed six missions on the Moon. Twelve men walked and drove around nearly 100 kilometers of its surface, and they delivered 400 kilograms of moon rock to the Earth. So what? Other than souvenirs and advertisements, those rocks weren't of any use to anybody, they provided no fundamentally new information to anyone except maybe geologists and geochemists. Mankind learned nothing that was fundamentally new.

I think that even for the rich Americans, $25 billion for a space show that was put on for prestige only is too high a price. After all, one would have to chalk up as lost those programs which could have been much more useful for such an enormous amount of money.

I don't want to denigrate the marvelous engineering work of the Americans. During the lunar program, the grand, well-coordinated work of the Americans produced not only the Apollo craft and the Saturn 5 rocket, but also a gigantic production and experimental base. That includes test stands for the rocket engines, equipment for readying rockets and spacecraft for launch, and much more. But note that after 1972, none of it, as a rule, was used, nothing was continued. The lunar program turned out to be a dead end. From my point of view, it's an example of a poorly chosen goal.

The same can be said of the shuttle program. Its "parents" promised to create an inexpensive transportation system capable of delivering 30 tons of payload into space for $10 million. From the very beginning, those figures were raised some doubt.

The years have gone by, and what's happened? It isn't $10 million, but $300 million that has to be spent for each flight. A small mistake, huh—like a 30-fold increase! It costs us 30-40 times less to deliver payloads into orbit on our old boosters. Why did we have to duplicate that senseless step and make our own Buran shuttle?

Vershubskiy: If only for the sake of space competition.

Feoktistov: What competition? The shuttle has been flying for several years, and we're already in our third year preparing for the second flight of Buran.

Besides, what's the purpose of competing in that area? What would we prove, and to whom? We haven't proved anything, ever. We surprised some people, we shocked others. Who? The journalists who wanted to be shocked? The person who doesn't understand that all of those items of the military-space complex are being paid for out of his pocket.

You can't say that that competition hasn't helped us, the engineers, to get money for our projects. We said, "We can be the first to send a man into space." "It can't be done!" "Yes, it can, it's as simple as can be." "OK, we'll give you some money." "We can send a craft to the Moon," "Go ahead" and so on.

In other words, the competition was in the interests of those who were involved in the creation of space equipment and in space research. And it was, to some extent, not useless, because it served to move mankind forward. But it's another matter that money earmarked for space systems was frequently spent inefficiently. Besides, more than two-thirds of space appropriations went to military space.

I'm not at all against reconnaissance satellites. Although there is something not quite right about eavesdropping on each other. But what else can we do? That's the way it is today. The twentieth century has demonstrated to mankind more than once that criminals and maniacs can seize power or infiltrate their way to it and then, using terror and the foolishness of their compatriots, try to take over a neighboring nation. The events in the Persian Gulf are not the only confirmation of that. That's why satellite reconnaissance is probably necessary in these times. Moreover, it wouldn't be a bad idea to create an international system of spacecraft for round-the-clock, all-weather observations of the land and sea and of the airspace and underwater conditions. That is entirely feasible for today's space technology. Such a system, open to everyone, would allow interested people from various nations—not just successful and indifferent bureaucrats—to monitor suspicious troop movements and military preparations. Thus, one would be able to cool the militaristic fervor of gangsters who have gained power and to prepare well in advance to repel their aggression or even to stop their preparations.

Today's space technology makes it possible, in theory, to create a monitoring system which would help to stabilize the international situation and reduce tensions, and as a result, it would make it possible to spend more money and focus more efforts on civilian production and on the welfare of the people. It is important that expenditures for the creation and use of such a system could be borne by the entire world community.

Here, however, money must be spent sensibly. It seems to me that now we launch too many disposable reconnaissance satellites which are in operation for a very short period of time. They shoot some film and come down. But the basis of surveillance should be different. And there is another way. We can arbitrarily call it a television satellite. That is, a television reconnaissance satellite records an image on board and transmits it to Earth. This is effective and inexpensive.

It should also be noted that too much money goes toward maintaining ground-based systems for servicing space flights and for the dozens of ground-based control and communications centers. Commands are issued from them or through them, and they receive and analyze telemetry information. That is frequently done "by hand."

Each center must have antennas, receivers, transmitters, a powerful energy-supply system, and communication links. Those centers are usually in remote places, in the taiga, in the desert. No one goes there willingly for miserly pay. Thousands of soldiers and officers are kept there. We could eliminate that if we automated the spacecraft to the fullest extent possible so that they analyzed their own work, evaluated the situation, and found the correct solution during emergency situations. That would make it possible for them to fly autonomously, with a minimum of communication links between them and the Earth. The problem is that our on-board computers are too primitive. Even the consumer personal computers are more powerful, cheaper, and more dependable.

Vershubskiy: So, you are for the continuation of the space programs? Exactly which ones, in your opinion, would it still not be worth it to skimp on?

Feoktistov: People are still not of just one opinion about the most important areas of human activity in space. Slogans like "The Mars Mission—An Inspiring Goal," "Let's Make a Giant Leap Forward in the Exploration of Space," " Let's Open the Future...," and "Let's Explore the Solar System" often replace well-thought-out, logical proposals in our choice of how to move farther ahead.

Soviet scholars working in basic sciences feel that it will be necessary in the coming decade to focus our efforts, as before, primarily on the study of near-Earth space, the Earth's magnetosphere, solar-terrestrial relations, the Sun, the solar corona, and other astrophysical research, all with unmanned space vehicles.

At present, the greatest success in space has gone to the relatively small unmanned vehicles used for studying the universe. They have produced unique, fundamentally new information: the existence of "black holes" has been confirmed, the transfer of matter has been detected in certain binary star systems, "black hole" and neutron star accretions have been found.

Vershubskiy: The Soviet Granat extra-atmospheric observatory observed—it was the first to do so!—a powerful source of annihilation radiation not far from the center of the galaxy.

Feoktistov: I haven't seen the actual materials from those studies, and I don't think I can judge them from from newspaper reports only.

Of course, applied-research and basic-research space programs both are not cheap. But if we choose the goals of our work, and do no unnecessary, worthless work, we could make a contribution to the general program of work of mankind in studying and using space.

Vershubskiy: But do we need that when we have empty shelves in the stores?

Feoktistov: I'm still not inclined to abandon the truth of "not by bread alone." To set pragmatic drives in opposition to people's natural desire to expand their sphere of activity, to know more about the universe and about their place in it would be wrong. It is more sensible to combine studies of the surrounding world with the desire to satisfy the essential needs of the Soviet people. The space program can be very useful here. For example, in America, Japan, Australia, and Western Europe, satellite communications provide millions of telephone channels. And what do we have? Several thousand. It is easier to shout something to the next town than to call. That has hurt the economy. The cost of creating satellite communications is smaller than the losses caused by the absence of such communications.

We must not eschew expenditures on satellite meteorology; navigation for ships, aircraft and ground transportation; or a system to help those in distress on land and sea. And of course, we cannot get by without space-based prospecting or without monitoring of the state of the ecology—something we have a vital interest in.

Finally, we must not cease work on orbital stations. That's practically the only place in space technology, and in technology in general, where we maintain the lead. Our work has proven that man can live and work in weightlessness for lengthy periods. But there is no point in flattering ourselves with those successes. There are, as yet, no practical, productive results.

Nevertheless, there is hope that weightlessness and the vacuum can be used to good end to produce superpure biological preparations, crystals, and optical glass-fiber in processes which are impossible to effect on Earth. Up to now, however, all we have is talk about how space factories could yield billions in profits. The work now being done aboard the space station cannot be called serious.

That reproach, of course, also refers to me. But basically, all of our energy has gone toward "making some headway" with the station itself and its craft. As soon as talk turned to supplying them with modern research equipment and experimental equipment, we came up against a rigid lack of understanding from the leadership. All they want is for us to make a little checkmark and report that the next station has been launched. The rest are "minor details" that don't help them to climb up the career ladder.

As before, the production experiments are conducted primitively, in small ampules. But if we threaten to start up industrial production in space, we have to create in-orbit pilot plants. It doesn't matter if they're different or smaller, they just have to be plants. People tell us that that requires power capacities of tens of kilowatts. So what's the problem? Let's concentrate our efforts on that, and not on things that are just for show. Let's work on those problems through engineering and create a solid, comprehensive program of experimentation that will prove whether it actually makes sense to build an orbital factory. Let's balance it all in rubles: income versus expenditures.

Vershubskiy: You mean there are no such calculations?

Feoktistov: There are—in fact, there are too many. But they are all "pulled out of thin air" and serve only to deceive high officials. For that there also exist secret exhibitions: "Just look: all around is disintegration, unresolvable conflicts, but for us, you couldn't even dream up a better situation." And it would, in fact, be hard to dream up a better situation. But we still have no proof, no initial technical data that would enable us to design orbital factories and build them.

Vershubskiy: But is is necessary or possible to build large stations in space, like, for example, the Freedom orbital station, which the Americans propose to begin in 1994?

Feoktistov: If it is assembled from individual modules, then it is possible to build a rather large station. But it will be difficult to control. The enormous size of the structures that will hold the living quarters, the refueling stations, the production areas, the solar panels, and the transport craft will lead to substantial moments of inertia and will make orientation of such structures more difficult. The structures of such stations are too programmed, and that limits the ability to develop and improve station production and research programs. Add to that the fact that the inclusion of production facilities in a single structure leads to an increase in the level of microgravity in those facilities, which affects the quality of the products which are obtained. And the fuel tanks there are filled, as a rule, with self-igniting components, and the complex hydraulic system for receiving fuel from the supply craft and pumping it to users in the whole structure is very dangerous. That should be avoided. But then, the main "shop," the auxiliary production facilities, and the living quarters have to be close to one another.

There are several ways of eliminating those difficulties and contradictions. One of them is to create a cloud station in space, that is, a station consisting of several autonomous components—for example, the base living

quarters, a production and laboratory unit, and a refueling module. They would fly in the same orbit not too far from one another, at distances of somewhere from 10 to 100 kilometers apart.

The hardware needed to set up such a system already exists: systems that can determine relative distances and radial velocities with the necessary accuracy and systems of coordinate engines.

Vershubskiy: Konstantin Petrovich, what do you think about orbiting electric power plants? Are they really feasible in the near future?

Feoktistov: That is at least one possible direction the development of space research could take in the interests of mankind, to satisfy its essential needs.

Solar energy can be converted to electrical energy in many different ways. The simplest and most natural in our case is the use of semiconductor transformers.

To create orbiting solar electric power plants, we will have to learn how to assemble gigantic structures in space, structures that will have to be lightweight. From a panel of 100 square kilometers in area, about 10 million kilowatts of power can be drawn off, and that energy can then be transmitted to Earth. For solar panels of that size, we couldn't use the plates used in today's solar panels. They would be too heavy and too expensive. But recently work has been conducted with some success to create lightweight film panels. The mass of a square meter of the panel doesn't exceed several hundred grams.

Orbiting solar electric power plants would be profitable if the mass per square meter of panel, with allowance for the mass of the frame and other structural elements, were about a kilogram. That's entirely feasible. But in that case, the mass of a 10 million kilowatt station would be about 100,000 tons!

The creation of orbiting electric power plants can be profitable only if we are able to create film solar panels and transport systems which are truly inexpensive and truly reusable for delivering payloads into orbit. Then the expenditures per kilowatt of power for the orbiting electric power plant would be two-three thousand rubles.

Vershubskiy: But, if I'm not mistaken, that is one and a half or two times more expensive than atomic energy, two or two and a half times more than hydroelectric energy, and four to six times more expensive than thermal energy.

Feoktistov: So? Orbiting electric power plants wouldn't expend natural resources and, after a few years of operation, would be more profitable than thermal energy or atomic energy. The main thing is that those stations would be ecologically clean.

Vershubskiy: All of that is very tempting. But again the question arises, Is our economy, which is collapsing before our eyes, capable of carrying out all those grandiose projects?

Feoktistov: In the present situation, of course not. The solution can be seen in a decisive transition to a market economy. I think that the space industry should not be an exception. It is necessary to separate the client from the manufacturer, who must be freed of the administrative burden of a powerful department. If the government or a group of rich benefactors comes up with money for some research or investment, there should be a competitive bidding among independent firms. That's why I feel that privatization of industrial enterprises should occur in the space industry and in the military-space complex as a whole.

The only thing I fear is that through various manipulations the enterprises will turn out to be the private property of their current managers, princes and princelings. And among them—and this is what scares me the most—there are a lot of dishonest people. That is very dangerous for normal operation of the economy. After all, where there is unscrupulousness, disruptions and crises are inevitable.

Nonetheless, we need privatization. If the military needs good rockets, let them order them and buy them. Such orders are beneficial for firms. They mean large profits. But you have to fight for them. And if you don't get the order, then you go broke. But we still have enterprises that have gotten into the "defense business," are generously financed no matter what, and whether they produce anything useful or not doesn't matter. Isn't that why those who are fed, watered, clothed, and provided with other favors by the military-industrial complex are opposed to the creation of a market in this country? It's time they understood that no one is going to pay for a pig in a poke anymore. We don't have any more money to cast to the winds.

In conclusion, I would like to say that I cannot but agree with those who say that today our vain attempt at taking the lead in science in technology are, at the very least, laughable. It wounds our self-respect and is painful and offensive. But the country finds itself in this quagmire and God willing, we will get out of it. The space program could be of some help if it were stripped of its showy exterior and its excessive militarization, and if it were put on a business basis.

'Gonets' Satellite System To Provide Medical Data Services

917Q0135 Moscow IZVESTIYA in Russian
31 May 91 p 6

[Article by IZVESTIYA science commentator B. Konovalov, under the rubric "The World and Us": "The Price of Intelligence: How Soviet Scientists Are Trying To Break Through to the World Market"]

[Excerpt] [Passage omitted] It is clear why Soviet science is breaking through to the world market. But obviously, breaking through is not that easy. The nonconvertible ruble is creating many difficulties. One of the problems centers on payment for communications lines, which are

vitally necessary in the intensive exchange of information. And here our space program, which is also seeking an outlet to the world market, can come to the aid of Soviet scientists.

In the United States, a recent report given at a national space symposium by Academician M. Reshetnev was received with great interest. Academician Reshetnev is the general director of the Scientific Production Association of Precision Mechanics, and it was under his supervision that nearly all Soviet communications satellites and space-based geodetic and navigation systems were developed. Together with the Soyuzmedinform Scientific Production Association and the Scientific Production Association of Precision Instruments, the firm headed by M. Reshetnev established the Association of Manufacturers of Small Satellites and Representatives of Communications Services—Smolsat—which a number of foreign organizations are joining; it is becoming an international association.

The proposed communications system is based on low-orbit satellites. Supporting global communications from any point on earth will take a good many of them—36. But then, they are small and inexpensive. Six such satellites are simultaneously put into orbit by one of the least expensive series-produced Soviet rockets, the Tsiklon. The satellite system, which has received the name Gonets (or "Messenger" in English), will support the transmission of any data in digital form—telex, text, speech, database exchange, and data collection from environmental monitoring sensors. The ground receivers of the system are also simple.

It is characteristic that the Soyuzmedinform Scientific Production Association, headed by A. Kiselev, was one of the initiators of the establishment of the Gonets system. The State Central Scientific Medical Library, which is part of that scientific production association, is one of the first in the country to go "electronic." All the main works of our medical people are being entered in an electronic data bank, and exchange with the FRG has been organized. As a result of that, the entire world community has access to our medical database. It should be noted that the intermediary firm—Science Information Express Data—and Soyuzmedinform intend to use machine translation from Russian to English, and vice versa. In theory, machine translation is also possible for any other pair of languages.

At the Central Scientific Medical Library I also met representatives of the business counterflow—the directors of two English firms. In one of the halls of the library, an area is partitioned off for the Gippokrat commercial information system. There detailed information on all the equipment and pharmacological agents that are offered for sale by the firms to the Soviet market is stored in the memory of computers.

For having their data entered into that system, foreign firms pay in hard currency and receive in exchange a broad audience. Information is also made available to our clients on a commercial basis, but with payment in rubles.

"In spite of the difficult times," G. Ustas, head of the British firm Cornix Systems, said to me, "the Soviet market remains very attractive. For example, in 1989, some $3 billion of equipment and medicines were purchased in the Soviet Union. We hope that the establishment of the Gonets system will fundamentally augment the Gippokrat system and will make it global. The Soviet Union is the leader in the development of small satellite systems. Many firms have now entered the chase, but at the moment only your country can offer a system that is ready for use, and time in our rapidly changing world plays a colossal role."

As you see, our science and technology are not bursting onto the world market empty-handed. We would hope that we will still succeed in getting seats on the express train with the name "world scientific and technical progress."

Policy of Secrecy in Reporting of Soviet Space Program

917Q0153 Moscow NOVOYE VREMYA in Russian No 26, Jun 91 pp 40-41

[Article by Leonard Nikishin, under the rubric of "Science": "Space Dramas: We Knew Nothing of Some, Others Did Not Really Occur"]

[Text] The history of the Soviet space program is something of a trinity. The first member of the trinity is the official version. It is printed in newspapers, books, and journals and is presented in motion picture films. It is TASS communications, articles and reports, reviews and interviews, recollections and diaries. The second side is, so to speak, "for official use only." It consists of all kinds of documents of different degrees of accessibility: records, documents, resolutions and decrees. And third is the unofficial side—word-of-mouth "lore," rumors, and versions frequently supplementing or refuting the official information. Stories about heroes "storming space" even before Gagarin and losing their lives there. There is the story of the "real" end of the days of the first cosmonaut—not almost a quarter of a century ago in an aircraft accident, but recently, in a psychiatric hospital. Another version, attributed to the seer Vange, was that Gagarin was kidnapped by extraterrestrials. There were the doubts among the Americans about whether Leonov really made a spacewalk (it was even checked out!).

A new wave of space sensationalisms of the "third type" appeared on the eve of the thirtieth anniversary of Gagarin's flight. Among the main ones was that same story of unknown sacrifices of lives in space. The newspaper SOVERSHENNO SEKRETNO [Top Secret] published a good ten names. A book on the "space sacrifices of the Soviets" has been published in one of the countries of Eastern Europe.

Equated to Military Machines

B. Chertok, a former deputy of Sergey Korolev, appearing on television, spared no epithets about the authors of the publication. But who to believe after decades of official lies and silence?

Our space program has faithfully served politics, and that means that only great achievements and victories were possible. The secrecy was total. The design characteristics of spacecraft and interplanetary probes were secret (essentially, they were equated to military machines). And no one (except those with a "need to know") was allowed to know the names of the creators of the craft, or even the names of the cosmonauts who had not yet gone aloft. The plans and programs of impending launches were also top secret. But they did not even carry the same stamp of secrecy as did information concerning failures, accidents, and catastrophes.

People's curiosity, of course, was not satisfied by the victorious TASS reports or the loud (but quite uninformative) reports from the "sanctioned" special correspondents. Picturesque details, later becoming permanent legends, were passed from mouth to mouth.

But legends were also created, as was already stated, "on an official basis." Here's an example. Gagarin was launched, as everyone knows, from Baykonur. And that is true. But when that was first stated, it was not the truth. Because the small city of Baykonur lies several hundred kilometers from the Syrdarya River and Tyuratam village, near which the cosmodrome is situated. A clumsy "masking," God knows why. Today, of course, that is little significance, and the name has taken root (although, in the West, the cosmodrome has been called Tyuratam for three decades now). But it would probably make sense to apologize for the false coordinates of the launch site indicated in the official document: it was a matter of records. The same is true for the report that Gagarin landed in the craft—even though everybody already knows that he ejected prior to landing. That was the standard set-up for all the Vostoks.

The real drama of the first space flights surpasses anything that could be made up, but somehow they didn't have the heart to tell the truth (the whole truth). A case in point was the end of the flight of Voskhod-2 in 1965. The automatic attitude-control system fails. The reentry cycle is called off. Another orbit. Manual control with an error of 10° (it is still unclear why that occurred). The landing is 1500 km from the designated landing site—in the Perm taiga. For several days the cosmonauts, whose flight was tracked by the entire world, sat in a dense forested area, listening to the howl of wolves. But what did we hear about that?

The flight of Komarov in the Soyuz-1 took on an emergency character from the very beginning, when one of the solar panels did not open. The launch was postponed of a second ship, with three cosmonauts, who were to dock with the Soyuz-1. The Soyuz-1 flight directors made the decision to terminate the flight ahead of time. However, there was a failure of the automatic ion-propulsion attitude-control system and the ship remained in orbit. But using manual control, just before reentry, the cosmonaut, in order to "come in home," had to find the course on the Earth's nighttime side. Fortunately, the Moon was full, and Komarov, by weak moonlight, was did a brilliant job of getting his bearings. The ship went precisely to the computed landing point. But during the landing, the accident happened. On the spur of the moment, they dreamed up something clumsy about "tangled parachute lines," although in actuality the ship's two parachute systems had failed. OK, they hadn't sorted things out at first, but what prevented a later correction?

Our press devoted only a few lines to the emergency situation during the flight of Lazarev and Makarov. After all, when the emergency arose at the cut-in of the third stage of the booster rocket, the ship landed in an undesignated mountainous region on a steep slope, and the cosmonauts experienced an 18-g acceleration. I won't even mention the unsuccessful attempts at dockings; there were many of them and almost all were passed over in silence. TASS communications, without batting an eye, stated that the dockings were not called for by the program.

And major failures were accompanied, of course, by the most profound silence. To be sure, they were forced to report on the deaths of cosmonauts, but if there was a possibility of hiding something, they would hide it. After all, there were the catastrophes with the gigantic N-1 booster, the malfunctioning of an orbital station soon after the beginning of its flight (it was called a regularly scheduled Kosmos), and the explosion of a booster rocket on the launch pad in 1983, when they managed to save the cosmonauts. The entire world knew about it, but it was not deemed necessary to inform the Soviet people.

Without Ustinov's Permission

Among the space successes which brought us so much joy in the 1960s was a rather major success: the first soft landing on the Moon. The Luna-9 probe transmitted to the Earth a panorama of another world—also, naturally, the first such panorama. That was sensational! The Americans weren't able to achieve such a success until three months later.

But the joy of the pioneers was clouded. The transmission of the panorama from the Moon was completed late at night. If that had occurred in the United States, you can imagine with what speed couriers would have whirled through the night streets of New York or Washington in order to deliver the photograph for the morning editions of the newspapers. That was not the case with us. Without the consent of the "supreme commander," D. Ustinov, Secretary of the Central Committee, nothing could be done. Not even PRAVDA was an exception. No one went to awaken the chief, everything was postponed until morning. And in the morning the scandal broke.

Besides us, the British radioastronomer Bernard Lovell managed to receive information from the Luna-9. He interpreted that information and also obtained a panoramic photograph of the Moon (with minor distortions). Since Lovell did not require the approval of Ustinov, he took it upon himself to supply the world press with the first lunar panorama—it goes without saying, not without payment. Our photograph, however, approved for publication in the morning, was of no use to anyone, except the Soviet newspapers.

I recall the headline in PRAVDA: "It's not pretty!" And a year later, it was necessary to ask the assistance of B. Lovell himself in the reception of information from the Venera-4 probe.

And no one, in fact, went into space before Gagarin. It is true that his flight was not without complications. The orbit into which the ship was put was unexpectedly high; the instrument compartment and the reentry vehicle, which had separated prior to reentry, remained connected by strands of cables which had not been shot away, as a result of which they "entered" the atmosphere together, and the instrument compartment stayed behind only after the cables burned through. That also was a short drama—a drama involving people whose actions were viewed by the entire world and who knew that there was no room for error. However, in the general rejoicing which followed, no mention was made of them....

Importance of Commercial Space Market Stressed

917Q0118 Moscow ZA RUBEZHOM in Russian No 16, 12-18 Apr 91 p 1

[Article by Leonard Nikishin, deputy editor-in-chief of the newspaper RADIKAL, under the rubric "Seventy Lines": "The Age of Space Maturity"]

[Text] Cosmonauts and astronauts have already wound thousands of orbital revolutions around the terrestrial "ball of yarn." That first orbit whose 30th anniversary we are observing today went down in history. Everything has changed since the time of Yuriy Gagarin's flight—the world, the country, and the space programs themselves.

Not so long ago, at a congress of the International Astronautical Federation, I had occasion to talk with Thomas Payne, the director of NASA, at the time of his triumph—the landing of a man on the moon. "What do you think of what is in fact the end of the rivalry between the USSR and the United States in space?" I asked. "Thank God," exclaimed Dr. Payne, "we don't need rivalry, we need cooperation." A profound meaning is evident to me in that response: the spirit of rivalry is not always positive, and in the space "competition" between the USSR and the United States, it often, unfortunately, assumed a grotesque form. Indeed, today it's hard to even see who was really ahead—the launches were made almost simultaneously. The first American satellite was launched four months after ours; John Glenn was lifted into orbit 10 months after Yuriy Gagarin; Aleksey Leonov made a spacewalk in March of 1965, and Charles White made his three months later, in June. And so it went the whole time: Luna—Surveyor, Venera—Mariner, Salyut—Skylab, Shuttle—Buran. Us—them, them—us...

Joint projects have been extremely rare in this field full of "prestigious" tinsel. What comes to mind first of all, of course, is the docking in orbit of the Soyuz and Apollo ships in 1975. But that was a "sample copy." Brezhnev's "relaxation" shortly thereafter came to naught and, together with it, the hopes for the further development of space cooperation between the USSR and the United States. Things went forward in only those few areas in which it was possible to reach very specific agreements. In particular, a large success was the establishment of the COSPAS-SARSAT satellite system, in which the contribution of the USSR and the United States was decisive. The "orbital patrol" is credited with hundreds of lives saved.

But that is only a drop in a sea of missed opportunities! The exchange of satellite-derived weather information won't fill the yawning gap, nor will Vega-type international projects or the participation of foreign guests in Soviet orbital missions. After all, today for us the expansion of international activity in that sphere is a powerful requirement of the times. First of all, we are not even talking about the benefits and advantages of that path; it may turn out to be the only means of saving, at a high cost, the intellectual, technical, and industrial potential that we have amassed and that is so necessary for our national economy.

As luck would have it, life sweeps away many artificial obstacles: just recently, our supersecret space "P.O. boxes," which couldn't have even thought about contacts with foreigners, have now started holding talks with them, are sending their own specialists abroad, and are promoting joint projects. Glavkosmos was established to assist in those matters. The trouble is simply that that institution itself is not active enough. It must be confessed that Glavkosmos was established only as a "cover" for the powerful and secret Ministry of General Machine Building.

In my opinion, the Intercosmos Council, which is part of the USSR Academy of Sciences' system, is doing very little of significance today. But the most important thing is that, our space-related enterprises to this day do not have a real outlet to the world space market. And the competitors are not sleeping! It was only recently that China became one of the space powers, but it has already managed to enter into a number of agreements on inserting other countries' satellites into orbit with its launch vehicle. A line has formed to the European Arianespace Consortium, which is also engaging in that activity. We, however, even though we have a whole fleet of splendid launch vehicles, have done very little in that regard for all practical purposes. And yet, a few deals

(any one of which would be a large project) could fundamentally change the situation.

Several years ago, the Soviet Union proposed in the UN an interesting project for the establishment of a World Space Organization that would be a center for coordinating operations on space exploration. For some reason, no one remembers that today, and that includes us.

Career, Views of Designer G. M. Gromov

917Q0117 Moscow PRAVDA in Russian 30 May 91 Second Edition p 3

[Article by Vitaliy Mikhaylov, Leningrad-Moscow, under the rubric "A Contemporary of Ours": "The Designer: An Encounter With a Person the General Public Knows Nothing About"]

[Text] It sometimes seems to me that in a time filled with the turbid medium of malice, skepticism, fear, meanness, and treachery, we have forgotten how to rejoice over the things our homeland does, and how to be amazed at them and take pride in them.

Worn down by the lines and the rumors, deafened by the chorus of reviling oracles in academic robes and in the deputies' freshly ironed three-piece business suits, we are ready to forget that we are a great people who not only were once wealthy in terms of expertly skilled craftsmen, but will be again.

Indeed, an inferiority complex, a lack of faith in our own powers and capabilities, and a servile mentality among consumers—all of which have been skillfully introduced into our consciousness—are having a destructive effect on our spirit. It's as if someone wants very much to train me to live in exclusive reliance on Western handouts, and to turn the people into a humbled throng devoid of a sense of human dignity and into John Does who do not remember their lineage. And as if on the instructions of diabolic forces, the distinctions are erased between what is great and what is absurd, between what is beautiful and what is abominable.

And yet, there's more than just impudent politicians in the the world. There are still and will always be plenty of zealots and dreamers. I had no sooner uttered that word when I winced, as if someone suddenly smiled maliciously—did I remember, he said, the "Kremlin Dreamer." Yes, I remembered. And I will not forget him, for without dreams there is no future, and without a future there is no life.

That is roughly how my interlocutor and I conversed about how everything is now, as we attempted to understand what is happening to us. Let me introduce him: a native of Leningrad and a fellow countryman. A longtime comrade, doctor of technical sciences, general designer of the electronic landing system for the Buran orbital ships—Gennadiy Nikolayevich Gromov. However, in his appearance, his figure, he derives nothing from his family name. And there is no noble gray hair on the temples, no portliness, no metallic hardness in the voice. He is lean, with a boyish figure and a smart appearance.

The general public does not know Gromov. He does not appear in the newspapers or on television screens—so how could they know him? But anyone associated with aviation and the space program knows him well. Both in our country and outside it. They know him and appreciate him.

He is a typical representative of his generation, his time and his city. He was born in 1937 into a worker's family, he's a survivor of the siege. His father died fighting the fascists in December of 1941. In the battle for Leningrad, I would note, not for Sankt-Peterburg. As the son of a front-line soldier, Gennadiy was accepted by the Suvorov school. "The Suvorov school gave splendid training. We were taught to be strong and courageous. We had boxing, gymnastics, swimming, fencing, skiing, and field and track. We were taught what is good, we were taught beauty. We were taught patriotism and comradeship. Twice I marched in a parade in Red Square. There was an exquisite, unforgettable and unique sensation of order: this was not a boyish crowd, but a military brotherhood—there was strength, power, and fellowship of comrades."

To Gromov, everything is "exquisite" and "splendid"—his two favorite words. The Precision Mechanics and Optics Institute is an exquisite VUZ, especially the radio engineering department. NIIRA (the Radio Apparatus Scientific Research Institute), where he was assigned, is splendid. The laboratory where he began is exquisite. The university's Physics and Mathematics Department is splendid.

Why this reference to the Physics and Mathematics Department? "When I started to work in the laboratory, I felt my theoretical training was inadequate." Yes, on general grounds, he entered the evening division of the Physics and Mathematics Department. He worked and studied. After classes, he would go to the beach at Petropavlovka. "Yes, of course, even at night." He swam until the first ice appeared. "It was exquisite!"

If I were to attempt to isolate what is central to Gromov's character, I would note two traits—the curiosity of a youth, and the reliability of a man. Reliability means honesty. And without inexhaustible curiosity, there is no real scientist. If you want to achieve success in your own "narrow" field, it is necessary to know contiguous fields quite well. When he was the head of the laboratory, to the surprise of many people, he took an interest in bionics. He went to the "big man"—Timofeyev-Resovskiy. "An exquisite person and a marvelous scientist, he is from the 21st Century."

I put a "provocative" question to him: "You worked on the Buran project for many years after the American

Shuttle flew. Do you acknowledge that you 'stole' something from them or, perhaps, the intelligence service helped?"

"No, those are common ideas, common to all humanity. Incidentally, I am very well acquainted with my American colleague. And as for who began first, well, in my laboratory, back in 1965-1968, a landing support system for a 'small' Shuttle was being modeled. It was called Orbita [Orbit]. The Mikoyan design bureau worked with us. The reports are lying around to this day, they're magnificent records. But then we were told not to be bothering with it."

Who said so, and why, remained unspoken. He avoided answering. That is apparently some kind of common trait among all defense workers—the leadership's orders are not to be discussed, only carried out.

"Leaders are supposed to be broadly educated people, responsible for understanding and seeing the long term and being people of vision. A leader is a fanatic, extremely devoted to his own affairs, and an obsessed person."

I ask if he had encountered many such "fanatics."

"Quite a few. But let's not name names. Scientists are easily injured people. If someone is not named, he would be offended for the rest of his life."

Here Gromov again "mounted" his favorite "topic" and heatedly began to explain the reasons for the delay in launching Buran:

"In 1963, our institute participated in the development of the TU-144 supersonic passenger plane. This was a most splendid concept. That kind of program advances technical progress in dozens of fields of science and industry. But we closed it down. Once again, on orders from above. And it was a fatal mistake we made. Did we spare the money? Well, if a kopeck were invested in the matter, then you would get a kopeck back..."

The course of the conversation turned to Buran. I asked Gromov: "Why did the Americans not go on to automatic landing of the orbital ships?" "Simply because it's expensive." And how did Gromov regard the Shuttle flights for the Pentagon's program?

"That doesn't bother me. Incorporated into the Energiya-Buran system are something like 20,000 of the latest technical and technological achievements that can be used in the national economy. But how many are being used? Zero point zero. And you know why not? I'll explain. The Americans publish an annual report that lists the achievements of space science and technology. Those innovations are disseminated by NASA and the Department of Defense, i.e., by state organizations. But they are disseminated for large sums of money. We, on the other hand, are still trying to introduce advanced know-how free of charge: if you want it, take it, if you don't want it, don't take it. So they don't even think of taking it. Our institute developed an instrument which can be used in all the machine building ministries. It costs 1,000 rubles—practically a gift. Why we set such a low price, no one knows. And what do you think—they still don't take it. It's laziness."

After that, the conversation followed a similar vein—about the market, about private property and the new forms of management. Gromov didn't even forget about socialist competition or what we used to call moral incentives:

"As always, we go from one extreme to the other. First we created giant associations [obyedineniye], and all of a sudden it was small enterprises that we were talking about on every corner, as if some miracle was going to save us. Yet, we still allude to some 'nonexistent' know-how."

But know-how is important. Take, for example, the fact that, in America, there are 500 powerful companies in operation that have 80-90 percent of the production volume—state orders. The state prefers to deal with large companies that are capable of solving problems of any technical and organizational complexity. It's those kinds of companies that get honor and respect, and state support.

But the small enterprises, according to Gromov, endure poverty and destitution of spirit. Why, in the West, do they go ahead and establish small enterprises—even if it's primarily in light industry? The explanation is quite simple: at such an enterprise, there won't be a trade union or any kind of party cell. Thus, it is easier to suppress dissent.

"They say to me there: Gennadiy, you have a state company, which is great; so why bother with privatization? They have taken a lot from us: they have programs for social and economic development, as well as monthly, yearly and long-term plans. But the most astounding thing is that they now have placards of honor hanging up just like we used to have. They even have 'special notices' that say that last month, so-and-so was the best at his job, and he is given the right to park in spot No 1 (the best, of course). And there is nothing surprising about this. It has long been known to the entire world that if a person, in addition to his wages, is offered for his work the choice of money, a photograph or certificate or a medal, 90 percent will turn down the money. Money disappears, but a word of praise will be passed on to grandchildren and great-grandchildren."

Later, Gromov and I agreed that some of our politicians are working for destruction, whereas creation is being pursued by those who go to their machines every morning, who sit at the displays, who milk the cows and make the steel—in brief, those who do their jobs. It is because of those very people that, as before in our country, the ships leave their berths, the trains speed along, the airplanes fly, and heat and light is fed into homes.

The perception is that those who engage in politics are basically failures who could not hold their own either in science or in the economy or in other sectors. They are people who are completely devoid of the joy of discovery and knowledge. And they are attempting to deprive others of their dreams and of the joy of knowing the everyday miracle that we call life.

I do not know what motivated those who made the decision to classify information about our homeland's highest honors being given to the Soviet scientists, workers and designers who developed the Energiya-Buran space system.

I do not understand why we cannot, should not, be proud of our compatriots who, despite everything, are continuing to work, to act, to overcome, and to lead the country out of crisis and think about the heights of progress.

But let's listen once more to Gromov: "Has perestroyka helped me? Not me personally, and not my firm, either. Conversion? Conversion in firms engaged in the development of science-intensive products is senseless. You know, when the Japanese journalist flew into space, I got bent out of shape by the reporting of our commentator from Baykonur. Oh, how he fawned on the Japanese. How, enraptured, he showered praise on the Japanese television equipment, and how he was moved. Well, give me a break, the transmitting camera was roasted at the moment of launch, because it had been positioned right under the nozzles of the rocket's engines. That commentator forgot about the main thing, that both the ship and the rocket were Soviet products, ours, without a single foreign rivet, and that it was our observation and control facilities and our specialists who were making the flight possible."

Systems developed under Gromov's leadership are also part of the armament of the Soviet Army. That also needs to be mentioned. His latest development ensures the landing of aircraft on the deck of a heavy aircraft-carrying cruiser.

I. Kurchatov once said: "I am happy that I was born in Russia." Gennadiy Gromov always repeats those words. They are the creed of his life.

Problems in Conversion of Facilities of Ministry of General Machine Building

917Q0155 Moscow IZVESTIYA in Russian 9 Jul 91 p 2

[Interview with Vladislav Kharlampiyevich Demtirov, chief of the Scientific and Technical Main Administration of the USSR Ministry of General Machine Building, by IZVESTIYA correspondent V. Litovkin: "How To Earn Money for Conversion"; first two paragraphs are IZVESTIYA introduction]

[Text] The product of the USSR Ministry of General Machine Building is rockets: live strategic missiles, operational-tactical missiles, and rockets for peaceful space research. But at its plants they also make refrigerators, equipment for the processing sectors of the agroindustrial complex and light industry, color televisions, tape recorders, tractors, and even streetcars. Peaceful production accounts for 40 percent of all the output. In 1995, that figure should be 60 percent.

How is conversion going? What problems is it posing? How are they being solved? V. Demtirov, chief of the Scientific and Technical Main Administration of the ministry, answers the questions of our correspondent.

Litovkin: Vladislav Kharlampiyevich, I know that your ministry is in its third year now working on the conversion program. What has it brought you—good or bad?

Demtirov: A very difficult question. Of course, for all of us, sensible people, it can only be good. But in practice, conversion is an extremely painful process.

Litovkin: Why?

Demtirov: The reorientation of enterprises of the defense industry to produce national-economy commodities should be a result of a well-thought-out plan that has been drawn up with allowances made for all the consequences. But what do we have now? Confusion in the system of material-technical supply, disruption of deliveries of materials and components, low wages.

Litovkin: But that's the general state of our economy.

Demtirov: Unfortunately, it is. And we have begun to feel that fully. But efficient organization of labor and smoothness of production were always our norm. It is easy to guess what harm the total lack of balance in the economy has done and is doing to us. It is very disturbing that the production equipment our plants developed with such difficulty for the processing sectors of the agroindustrial complex often turns out to be not needed.

The leaders of a number of republics and oblasts are extremely inefficient in using the machines and units produced by us. Here are specific examples. As of 1 January 1991, consumers had accumulated equipment worth about 3 billion rubles [R]. And since the beginning of this year, stocks of that equipment have increased by another R700 million. That is considerably more than the annual output. Among those stocks are equipment for the production of sugar, sausages, and ready-to-cook meats; equipment for oil and fat production and baking; and candy-making equipment. Everything that the country is extremely short of. Nearly every republic has a sizable "reserve": in Russia, equipment worth R1.6 billion has "grown stale"; in the Ukraine, that figure is at R500 million; in Belorussia, R164 million.

It is not enough that the sector is not receiving any subsidies for conversion, now it cover its expenses. We're faced with an urgent question: How are we to survive?

Litovkin: And how will you? What's the answer?

Demtirov: In specialized state support of conversion. First of all, legislative support, then material-technical support and social support, and, of course, financial support. Unfortunately, the government conversion program, which was adopted a year ago, is not backed by anything, nor has a mechanism for its implementation been developed. There is simply no money for its implementation.

Litovkin: But why don't you earn it yourselves?

Demtirov: We have here our own "buts." Maybe the Ministry of the Aviation Industry could, say, make civil aircraft instead of military aircraft or increase the output of military aircraft so it could sell them abroad, and with the money it gets reorganize production. But we can't sell our rockets. So we have to approach the issue in a different way.

Here two roads are possible. Let us arbitrarily call one quantitative and the other, qualitative. The former calls for increasing the output of "peaceful" products for space: more communications satellites, repeaters, navigation satellites. And we are using that lever to the full extent. However, that lever is not without its limits, and the need for such hardware is limited.

That means, we have to "work out" a second version. And to begin with, we have to radically revise our attitude toward equipment for the processing sectors of the agroindustrial complex as "second-rate" products. After all, the equipment now being used abroad is, for the most part, the result of state-of-the-art engineering and technology. We've also produced such hardware.

Take, for example, the vacuum mincer—a piece of equipment for processing meat and producing ready-to-cook foods from it. It has the most complicated technology and electronics in the program control system. Aleksandr Dmitriyevich Konopatov, our chief designer of rocket motors, and Anatoliy Sidorovich Kashchuk, his deputy, did the work on it. They developed a piece of equipment that we are not ashamed to show to the world. The FRG is the absolute arbiter of fashion in the production of equipment for meat processing, and their specialists checked our 125-liter mincer out every which way. It has some unique design solutions. But our processing industry refuses to purchase these mincers.

Litovkin: They probably too expensive for them, right?

Demtirov: The old equipment—the "cast-iron stuff"—is probably cheaper. Moreover, it processes any raw material. But this is a completely different level. Such equipment requires respect, and you can't substitute anything in it for meat. And it costs R80,000. And so of course it's not "handy" for our consumer.

But if you consider that 80 percent of the processing industry is outfitted with imported equipment and paid for it with currency, and then convert that cost at the official exchange rate, it will turn out that our new item is less expensive and, in terms of quality, is not inferior to imported equipment.

Litovkin: If they begin to buy up your equipment, the trips abroad will stop?

Demtirov: I am talking about the state approach to the matter, not the bureaucratic approach. Let's calculate. The development of all the equipment for the agroindustrial complex in accordance with the government-approved program for the Union as a whole costs approximately R500 million a year. If we were to agree to such spending over three-four years, there would appear in our country our own world-class processing plants, production lines, and individual types of equipment that we could saturate the domestic market with, without spending annually several billion foreign exchange rubles on the purchase of food products and equipment abroad. Then the time would come when we could sell our own equipment abroad. To act otherwise means to doom ourselves to the need for annual import purchases and to being perpetually behind.

But for the time being.... They are cutting off to us the financing of operations. The government program is up in the air. The State Commission for Foodstuffs and Purchases thus far has not concluded a single contract for 1991. Soon there will simply be nothing for paying the wage of workers, technicians, and engineers—the elite of the country's scientific-technical potential. Is that really the state approach?

True, several days ago they said that, supposedly, R80 million had been allocated for next year. But, look, we alone need R162 million, and we are in charge of seven systems of machines for such socially important sectors of the food industry as the baking, meat-processing, oils and fats, confectionery, sugar-making, yeast, and potato-processing sectors—that's 25 percent of the total production volume. Just where are we supposed to get the remaining money?

We appealed to the republics. We found some understanding there, particularly in Russia and Kazakhstan. There's a little light at the end of the tunnel, but not enough to make us feel good.

Litovkin: You talk about the expensiveness of your products, and specialists of the processing sectors are also complaining of that. Maybe one way to save money would be to lower the production cost?

Demtirov: Of course. And overcoming that barrier is for us the problem of problems. The former high prices were due to the specific nature of our work—piece-by-piece production and the necessity of exceptional reliability. Energiya, Buran, and the Mir station—those are our products. Thousands of people and entire complexes of scientific research institutes, design bureaus, and plants participated in their development. Of course the prices were "astronomical." Now the situation has changed. At

the same plants we are starting to set up series production. And that means that the entire production process should become different. That's one side of the coin. But on the other side the question of achieving the necessary, adequate quality of those series-produced items themselves inevitably arises. The former scrupulous form of inspection—of each part as well as of the item as a whole—is now completely unsuitable. There is simply no time for that. Which means we have to abandon it, but at the same time bring the technology of manufacturing machines up to such a level that the very possibility of a defective product is eliminated. Well-known western firms operate precisely that way.

Litovkin: Another means of earning money for conversion seems obvious to me. Before meeting with you, I visited the sector's exhibition. Why not increase the production of the televisions, refrigerators, and washing machines which are exhibited at it?

Demtirov: Alas, not everything is as simple as it seems. Last year, we increased the production of consumer goods by nearly 1.4-fold. That is the limit of our capabilities. In order to go farther, we need not only components—other sectors supply them—but also a production base, i.e., new plants, new equipment, new work areas. Where are we to get them?

Don't be suggesting that if we used to make 200 rockets, but now make only 20, we can replace the other 180 with televisions or refrigerators. Equipment of a different type is required for that.

The production base, test stands, and the entire set of production equipment are the same for one rocket as they are for 100. It all has to be kept in working condition, and this costs money, and a lot of it.

How are we supposed to increase the production of those refrigerators? You have to seek out new molds. Obtain bank credit, set up a joint venture.... We are making such attempts. For example, in Orenburg, at the Strela Production Association, we decided to set up a joint venture for the production of absorption refrigerators. In addition to us, two foreign firms will be a part of this venture. We have determined the share of each party.

Our capital is simple—buildings, structures, electric power, water, and all the rest. But some amount of currency is needed—approximately R7-10 million—so that our share would come to 45 percent. We asked for that money, but we didn't get it. Foreign banks are willing to grant us credits, but the Bank for Foreign Economic Relations is not providing the state guarantee that that credit will be repaid.... And that plant alone can yield us annually a profit of R200 million.

Litovkin: But the Bank for Foreign Economic Relations is not the last resort. There are also the Cabinet of Ministers, the prime minister....

Demtirov: Unfortunately, there they are waving us away. They keep saying that there is no money and none is expected, and they suggest that we look for it somewhere else.... And they are not providing any guarantees, either.

Litovkin: But why can't you "borrow" the money from the workers of the plant and give them an opportunity to become its shareholders? Or offer shares to foreign companies? I know that there are those people in the country who are willing to spend their money—including hard currency—on a profitable business. Can't you take the route of establishing at your plants small enterprises and give them an opportunity to earn money for conversion? Or is the ministry afraid that it will cease to be the owner of the enterprises and will be unable to give them orders as before?

Demtirov: We are not afraid of this. And although our functions are changing and the administrative-pressure tactics of work are receding into the past in terms of our relations with enterprises, believe me, we will still have enough ways of influencing plant policy.

It's a matter of something else. We have very expensive productive capital. The "cheapest" plant runs R40 million worth. Some 4,000 people work there. Do you think that they have enough money to buy back the equipment? I am certain that they don't. Even if a share were to cost R1,000 and everyone, including the cleaning woman, were able to buy one each, that would be only R4 million—10 percent of the cost of the fixed capital. Where would they get the rest of the money? And what about money for renovation? And for setting up new production?

In principle, though, you are right. We have to be more bold about using new, very diverse possibilities. We are trying to do that, but, honestly speaking, it is very difficult to overcome the old psychology. We have come full circle to the notion that the state should help us as it helped us earlier. And how can it be otherwise? After all, whoever orders the music should also pay for it.

The market is a good thing, but it is not a panacea. Judge for yourself. The market requires a quick return: you get a loan from a bank, and you have to pay it back in a year or two. How can a small enterprise do that? Only by buying some very simple equipment—for example, for stamping out plastic pans. And it begins to rivet them. They get sold. The enterprise geta another loan and expands production, now for some other consumer good.

Consumer goods are also scarce in our country and are, undoubtedly, needed. But it is impossible that way to saturate the domestic market with complex, science-intensive high-quality commodities like motor vehicles, automatic washing machines, VCRs, refrigerators, microwave ovens.... Those products won't manage without state capital investments, without a long-term state science-technical policy. We will get even farther behind.

But for that not to happen, scientific-technical progress has to be managed with economic levers, preferential

tariffs, tax regulation, subsidies, credits, and nonbudgetary resources. We need a mechanism of performing the conversion, or it is doomed to failure.

Designer Suggests Using Scrapped Military Missiles for Space Launches

917Q0181 Moscow KOMSOMOLSKAYA PRAVDA in Russian 16 Aug 91 p 2

[Interview with Aleksandr Anatolyevich Rasnovskiy, a lead designer for a defense-related scientific research institute, by A. Khokhlov: "Let's Send the Missiles Into Space..."; first paragraph is source introduction]

[Text] **Aleksander Anatolyevich Rasnovskiy is a lead designer at one of our defense-related scientific research institute. He came to our editorial offices and proposed that the missiles "scrapped" by the recent Strategic Arms Reduction Treaty not be cut up into scrap metal, but rather, that they be launched into space. For what purpose?**

Rasnovskiy: There is now no use for them on Earth—and thank God. But wouldn't it really be a pity to turn into scrap a high-technology product like that, perhaps the only one the USSR has produced on a world-class level? Over a 40-year period, no fewer than a trillion rubles [R] have been spent on the development of Soviet missiles. The residual value now is R100-200 billion. To convert them into scrap metal would also require more than R1 billion. I believe that it would be more worthwhile to launch the missiles into space. They would be useful for space construction using materials mined on the moon or the asteroids. First of all, we must construct space-based power plants.

Today, humanity obtains around 90 percent of its energy by burning fuel. More and more energy is needed, and, therefore, the extraction and burning of oil and coal will increase. But indeed, people themselves will thereby destroy their own future. There is only one way out—begin to employ non-traditional sources of energy and, first and foremost, the energy of the sun.

Khokhlov: But, look, isn't that unprofitable at the moment?

Rasnovskiy: On the ground. If we construct power plants in space, they will pay for themselves in 20-25 years and will produce a colossal profit.

Khokhlov: How is it possible to transform a missile from the category of a weapon into something else?

Rasnovskiy: It is necessary to remove the nuclear material from the warhead. All the "equipment" and all the "little things" which make the bomb a weapon will be destroyed, just as is specified by the treaty. Only the nuclear "stuffing" will remain, and that in itself will no longer "fire." The mass will decrease by 30-35 percent. That is enough for the missile to be able to develop the escape velocity necessary for entry into a near-Earth orbit. It is necessary to establish nuclear storage facilities in space, where, for example, "energy clusters" under guard will await use. Technically, all the stages of this process are realizable at the current level of development of space technologies.

Khokhlov: Fine. Let's assume that we have constructed the power plants. What then? After all, don't we lack the means to transmit the power to the ground?

Rasnovskiy: They will be found in the near future.

And the primary task of space-based power generation should be to light up cities. In New York alone, that costs $100 million annually. What must it cost for all the cities of the planet? A network of 24 space-based power plants would make it possible to serve all the large cities.

Khokhlov: In order to carry out such a program, it would be necessary to sign a "worldwide" agreement.

Rasnovskiy: It seems to me that humanity has no other choice. It is possible that, if an agreement is not signed in the next 10 years, then there will be no sense in coming to an agreement later—catastrophic changes may occur in the Earth's atmosphere. We must not let the unique opportunity of using Soviet and American missiles for this purpose to slip by. Otherwise, over a five- or six-year period, humanity will have to lay out many billions of dollars, rubles, rupees and so on....

Khokhlov: Perhaps it would have been better if you had submitted this idea prior to the signing of the Soviet-American START Treaty.

Rasnovskiy: For seven months, I haunted the thresholds of the union and Russian supreme soviets. In vain.... But, perhaps, it is not too late to revise the treaty? After all, we are talking about the fate of all of humanity.

Blagov, Leonov Comment on Space Sector Reaction to Coup Attempt

917Q0182 Moscow IZVESTIYA in Russian 31 Aug 91 p 4

[Comments by V. Blagov, deputy mission director at the Flight Control Center, and Maj Gen A. Leonov, deputy chief of the Cosmonaut Training Center, as related to IZVESTIYA correspondent S. Leskov: "The Coup: The View From Space"; first paragraph is source introduction]

[Text] **How did our cosmonauts feel about the alarming days of crisis? How did the crew currently working in orbit respond to the news about the coup d'etat? Here is what Deputy Mission Director V. Blagov said to IZVESTIYA's correspondent:**

"Plans call for an emergency landing if there are events which threaten the crew's safety. For example, if war starts. In this instance, the question did not come up. Each day, in accordance with the established plan, we transmitted to Artsebarskiy and Krikalev the most

important television broadcasts, radio reports, and newspaper articles. As the flight controllers noted, on 19 August, after the report about the fact that power had passed into the hands of the GKChP [State Committee for the Emergency Situation], a puzzling silence fell over the station. On subsequent days, we transmitted to the station both the decrees of the GKChP and the Decrees of the President of Russia. Along with the program VREMYA, the ECHO OF MOSCOW broadcasts were also relayed. But no comments or statements were made, and the crew generally showed great restraint. Moreover, it was during those very days that they had to deal with the particularly stressful operation of rendezvousing with the next cargo ship.

"The GKChP represented the interests of the military-industrial complex. Would the position of the Flight Control Center have improved if the self-styled committee had stayed in power for a longer period of time?

"Where would the money come from suddenly? Right now, our sector is experiencing a difficult period and the flights of foreign cosmonauts and the economic agreement operations with partners within the country are helping to extricate it. The annual program on the Mir orbital complex is estimated to cost 200 million rubles, and a single flight of a foreign cosmonaut yields for us around 330 million Soviet rubles. It is more likely than not that, in the event of a successful coup, contacts with the USSR in the space operations would have ceased. It is hardly likely that our cooperation within the framework of the new management mechanism in the internal market would have been developed further."

More closely associated with the events which occurred in the country were those cosmonauts who were preparing for upcoming flights and working in the Cosmonaut Training Center (CTC). Here is what Major General A. Leonov, deputy chief of the CTC, had to say:

"On 19 August, at 7 o'clock in the morning, the entire staff of the center was called into work on an alert. I will tell you frankly that, at first, we did not understand what had happened. But after the first few decrees of the GKChP and especially after the press conference, everything had become clear. The CTC's management made a decision to reinforce the guard and not to respond to any of the urgings of the coup's supporters. There was, for example, an order for the chief of the CTC to report for instructions to the rayon committee of the CPSU (*at this moment, our telephone communications were abruptly cut off—S. Leskov*). Still not knowing about the basic position of the Air Force commander in chief, we did not obey the party leaders and did not permit any actions in support of the coup. Meanwhile, in one of the neighboring garrisons, a meeting was held on Tuesday in support of the coup, while, on Friday, those same people organized a meeting in direct opposition to it.

"On the evening of 20 August, an assistant to Yeltsin phoned me and asked if it was true that M. Gorbachev had been sent to Star City by helicopter and was under guard at our place. I assured him that it was virtually impossible to fly by helicopter from the Crimea to Star City and that no other craft of any kind with the President of the USSR on it had landed at our airfield.

"It is my profound conviction that the coup d'etat ended in failure to a large extent because the army did not lend support to it. On 20 August, in Moscow, I saw the mood of the soldiers and officers, and I was 100 percent certain that they would not carry out any combat operations whatsoever against the populace."

Mir Crew, Flight Control Center Reactions to Coup

917Q0183 Moscow PRAVDA in Russian 31 Aug 91 p 6

[Article by PRAVDA special correspondent A. Tarasov: "The Orbits of Our Anxiety"]

[Text] [Boxed item: On 29 August, the Indian IRS-1B satellite was launched from Baykonur. The Flight Control Center is controlling its own space vehicles.]

The immortal words "Take off your boots and hide them, power has changed hands!" has gone up to those in space from their native land more than once. At the very beginning of the space age, the words were familiar to the crew of the first Voskhod craft, who were kissed and embraced by Khrushchev on their departure, but by Brezhnev on their return. One cosmonaut, it will be recalled, began having sharp internal pains on the very day of the latter's death. I also recall the orbit of the craft literally at the very hour of Andropov's departure from this life: in one communications zone, he was still alive, in the next one, he was already gone.

No matter what you do, "the river of time follows its own course"...

To put it briefly, while in space, it does no harm to keep tabs on goings on down on the ground. Yet, all the same, just imagine: you are high above the ground, in a sealed celestial can, tethered with the thin, invisible homing of radio waves, and, suddenly, that thread breaks, and there is total darkness, silence, complete uncertainty and no response.

God forbid.

Fortunately, nothing like that happened. The Flight Control Center, to me, is like a mother ready to sacrifice herself in time of trouble to save her own child.

"Oh no, nothing of the sort was necessary," Deputy Mission Director Viktor Blagov said, and being more seriously than usual, he brought the enthusiasm down a peg or two. "There was never any threat to the flight from any quarter. They worked under the usual conditions and carried out the flight program and all its procedures. We had no state of emergency imposed in Kaliningrad and the municipal Soviet authorities supported the Russian government..."

On the morning of the 19th, it was the 92d day of flight of the crew made up of Anatoliy Artsebarskiy and Sergey Krikalev.

"We have news for you, very important news," reported Igor Sukhorukov, the main capcom, in a voice hardly resembling his own, telling them the news about the imposition of the state of emergency.

The first reaction from aloft was: "But where IS the president?!"

"It has been reported that he is sick..."

Later, between the furnace, the platform, the medical check, the local items and the valves, they were given the details about the sole television channel ("only the VREMYA news program, movies and concerts") and the situation with the newspapers and magazines.

"The people will not get their wages," was the immediate sympathetic response from aloft.

It would be interesting to know if all the information about the terrestrial scrapes were transmitted to them. "Well, perhaps, you did not want to upset them, make them nervous, cause them mental stress or wreck their spirits? Might not someone's hand there suddenly shake and push the wrong button?"

"No, on the contrary, their nerves were strained by the shortage of information. All the Russian government's decrees and Yeltsin's appeal also were transmitted to them, just like in the Flight Control Center, over the loudspeaker, and all the momentum of the struggle. Fellows were running off to meetings, to Manezhka and to the "White House" and they were even let off their shifts... In order to participate and they had to see with their own eyes... They dug up the ground channel—and we watched the Russian [congress'] session from early morning on and not as of 5 PM, like everyone else..."

During the night on the 21st, at 0154 hours, the Progress M-9 cargo ship lifted off. "In general, the curfew messed things up, forced us to gather in the evening and everyone rushed here ahead of time. And there were the Austrians who had to accompany their own equipment. Judging by their looks, we thought, This may be bad, they may decide against flying with totalitarians..."

But it all blew over, and, on the night of the 23d, now under more humane conditions, the cargo ship peacefully docked with the complex. And, on the 27th, Sergey Krikalev received congratulations on his 33rd birthday. A woman's voice: "In the evening, at 2205 hours, we will raise our glasses again."

"Why, mom?" wondered the good-natured and touched birthday boy.

"That's the time you were born. We hope you will be coming home to Leningrad in October..."

"Not hardly," he said sadly.

I then added congratulations from all of us and asked what pleasant and vital things had arrived in the cargo ship. There was a bag of copies of OGONEK and ARGUMENTY I FAKTY (as fast as they get there, however, everything may be out of date already). There was also the Austrian equipment for trapping charged particles in a vacuum chamber—it was necessary to turn it on immediately, to conduct tests and to make the final adjustments: sitting around is bad for it.... There were cans of Coca-Cola—to wash down the days of anxiety and to combine advertising with an experiment on testing the "weightless" packaging....

"Serezha [Krikalev], how did you decide to continue the trip?"

"I simply went and decided," he said, without elaborating. "Of course, it is difficult and not very good for my health and, in general, there are certain things here which are incomprehensible... But a problem has arisen to confront the company—to condense the program and to conserve the ship... I should help the company."

"But is the company capable of showing gratitude?"

"When I return, we will see."

And now, let us return again to the main thing for this day. To the reliability of the people on whom a human life depends—by the thread of the outer and near compass locators.

And, after all, there are not only the lives of the cosmonauts. There are our babies with their young moms, there are our sick and infirm, our old people, and simply, our people. Everyone whom the flight of our anxiety so twisted up during these days.

The young Flight Control Center fellows ran past and began to swirl into small groups.

"Listen, but won't they come down hard on us because we did not strike?"

"Listen, but did you see on the board the leaflet of some provisional city committee? We have to make some noise to someone about the behavior of people around us during the days of the junta...."

Yes, soon the xerox leaflets on this board, full of just anger and honor, were replaced by others full of something quite different. But this is something painfully familiar....

Space Cooperation Agreements With France

LD3009052591 Moscow TASS International Service in Russian 2134 GMT 27 Sep 91

[By TASS correspondent Igor Kuleshov]

[Text] Paris, 28 Sep (TASS)—The mutual desire to develop cooperation in space exploration was confirmed

by the 27th meeting of Soviet and French scientists, which ended on Friday in the city of Tours, Indre-et-Loire.

As Vladimir Kotelnikov, chairman of the "Intercosmos" council pointed out in a conversation with a TASS correspondent, a whole series of accords on cooperation in the most varied fields was achieved during the meeting with colleagues from France's National Center for Space Research.

French scientists expressed a wish to become participants in the promising project to create the Romantis improved communications satellite, which is being developed by scientists of the Soviet Union and a number of other countries.

Agreement was also reached on numerous matters connected with expeditions to Mars in 1994 and 1996, including the distribution of scientific equipment in the course of implementing these two projects.

In the sphere of medicine, the scientists of the two countries agreed on matters relating to the conduct of medical research and use of medical equipment during next year's flight by the French cosmonaut, Michel Tognini, aboard the orbiting Mir station. French scientists will also take part in the implementation in 1992 of the Biosputnik-10 biological satellite project.

Important accords were reached in the sphere of meteorology. It was decided to begin development work on forecasting earthquakes taking account of processes in space and in particular in the ionosphere. This dependence has been repeatedly observed, but science is as yet unable to explain it. The hope is that if these processes are solved, there might emerge a new method for forecasting earthquakes, which is naturally of exceptionally great importance.

Deserving special attention among projects connected with Earth are the joint projects for studying atmospheric pollution, which will be precisely registered by laser instruments aboard a satellite flying above the Earth. Scientists of the two countries will also study matters concerning the loss of heat by the Earth, which is particularly important for predicting changes in the climate and the weather, the Soviet scientist stressed in conclusion.

Planned German, French Flights to Mir Will Take Place

LD0110023191 Moscow TASS in English 2031 GMT 30 Sep 91

[By TASS special correspondents Yuriy Konorov and Vladimir Khrustov]

[Text] Baykonur Cosmodrome September 30 TASS—All international space flights planned for next year will be held as scheduled and the Soviet Union will fulfil its obligations, state commission members told journalists here today.

Yuriy Semenov, general designer at the Energiya Science and Production Association, said the Soviet-German flight is planned for March and the Soviet-French mission for June. Part of hard currency received from these flights will go to develop Soviet cosmonautics, including the Baykonur Cosmodrome and the infrastructure of Leninsk, its capital.

Kazakhstan First Deputy Prime Minister Yevgeniy Yezhikov-Babakhanov said the forthcoming flight of a Kazakh cosmonaut demonstrated the enhanced level of the national science and the republic's aspiration to make maximum use of the achievements of space engineering in the interests of Kazakhstan's national economy.

Kazakhstan President Nursultan Nazarbayev's decrees on the republican space agency and the transition of enterprises on the republic's territory under the control of Kazakhstan will expedite the solution of these tasks.

Colonel General Vladimir Ivanov emphasised, however, that the Baykonur Cosmodrome's launch pads will continue to be under the control of the command of the USSR Defense Ministry's space forces.

'Space Scrap Metal' From Plesetsk Launches Collected

LD2009040491 Moscow TASS in English 1432 GMT 19 Sep 91

[By TASS correspondent Vladimir Anufriyev]

[Text] Arkhangelsk September 19 TASS—The clean-up operation to remove "space scrap metal" has been completed in the Soviet arctic regions above which Soviet booster rockets propel spacecraft into orbit.

Specialists of the Transres Research-and-Development Centre and the Plesetsk Cosmodrome had to hunt for used booster rocket stages, engines, parts of nose-cones and other things that had fallen from the sky in two extensive areas—the tundra of the Nenets Autonomous Region and in the Mezen District. Helicopters lifted about 245 tonnes of scrap metal from the areas.

A spokesman for the Plesetsk Cosmodrome press center told TASS that local residents had got used to "gifts from the sky" over the past 25 years, and some of them were averse to parting with the "celestial souvenirs". Deer breeders, for instance, have long been using nose-cones as a universal container for storing and transporting goods. In this way space technologies have long become part of Nenets shepherds' everyday life.

It was decided to collect space scrap metal every year. Specialists say this past summer they tested methods of collecting and transporting booster rocket parts without doing harm to the vulnerable environment in this region.

A special commission is now working in the Arkhangelsk region to establish what effect the cosmodrome has on its environment.

Clearing of Space Debris From Areas Near Plesetsk Cosmodrome

927Q0023A Moscow PRAVDA in Russian 28 Oct 91 p 6

[Article by Al. Antipin, Mezen Rayon, Arkhangelsk Oblast: "Launch a Rocket, Clean Up After Yourself"]

[Text] "Get ready!" We slide down into a gully and wait. Several seconds pass and the loud echo of an explosion races over the tundra.

"We" are a small team of the Moscow Trans-RES Scientific Production Center, specialists of the Plesetsk cosmodrome and a journalist of the Mezen newspaper "Sever." What is such a small team doing here, in the depths of the taiga. It's all very simple. We are bringing in a harvest, no simple harvest, but a space harvest!

During long years, and to be precise, already more than 25 years, the Arkhangelsk North has been inseparably associated with the work of the Plesetsk cosmodrome. The first space vehicle, Cosmos-112, was launched from these launch pads in March 1966. And since that time, each year, month after month, space rockets have been put into orbit. Plesetsk is the "workhorse" of cosmodromes. About 70 percent of all the launchings in the country are from this cosmodrome. Satellites of the Cosmos series, with the memorable numbers 1000 and 2000, were launched from here, as were the sympathetic monkeys, beloved by the entire country, and international space objects, such as very recently—the Soviet-American satellite Meteor 3/TOMS for exploration of the Earth's ozone layer.

But to simple citizens, residents of the remote north, it never occurred why suddenly there were cancellations of the takeoff of Aeroflot aircraft and they did not know what was being brought from the hayfields of kolkhoz workers, from the mushroom and berry fields. Although the clever Pomors, native inhabitants of these unpopulated places, to be sure, guessed the reasons for disturbances in the economic rhythm. Here have been situated and are still situated regions of falling of the separable parts of the boosters of space vehicles. Many quickly made use of the space "gifts" (stages, nose cone cowlings, fins of tail compartments) in their domestic economy. Here you have the working material for making different kinds of utensils and tools and almost ready-made boats. And what is there that cannot be fabricated from the excellent valuable metal, electrical equipment and storage batteries?

It would be erroneous to say that the falling stages cause only delight among the local inhabitants. No! disturbances in economic activity, and especially concern for the state of their own northern environment have led to protestations and justifiable dissatisfaction. As a result of all of this our space departments conceived the idea that it was necessary to clean up space scrap metal in the regions of falling.

And so this year such work was begun in Mezen Rayon in the polar region. A year earlier a beginning was made in Nenets Okrug, in a region of falling, under the conventional name "Naryan-Mar," and still earlier in Kazakhstan, in the "eparchy" of the Baykonur cosmodrome.

The tundra and the impassable swamps constituted a wall and it was not so simple to retrieve the fragments of rockets received into its bosom. In many cases it is virtually impossible to drive or walk there. This explains the complexity and substantial financial expenditures in executing this worthwhile mission. This work is of an exploratory- experimental character, since, after all, everything is being worked out here for the first time: both the technology of preparation of the stages for transport and the transfer of the booster parts themselves to the site of storage by means of helicopters, and much else which still requires study, thorough preparation and field testing.

In this sense as well it also is possible to mention the successful cooperation between the northern cosmodrome and the Trans-RES Scientific Production Center. This was discussed with me by V. Vasilenko, the chief of the cosmodrome section, and V. Lavrinenko, director of the Trans-RES Mezen expedition, during our foray into the region of falling.

... The order "All Clear" is heard. We get up from the shelter and hurry to the space stage. Now the side panel of the Soyuz booster was precisely cut into parts by means of fused shaped charge and was ready for transport.

It seemed to me that the operation for preparation of the stage for its transport from the falling site was rather secondary, but the Trans-RES specialists Ye. Kazimerchuk and K. Zhavoronkov convinced me otherwise:

"How do you prepare a stage in order to transport it from here?

"It is very creative work," confirmed Captain Sergey Otradnykh, who masterly cuts the stages on this expedition.

And here's the helicopter. Circling over us, it slowly hovers over the divided "carcass" of the stage. Now it grabs hold of the "victim" and drags it over the crowns of the sparse forest. But no... it is a failure on the first attempt.

However, if you are interested in the first results of the work of the subdivisions of the cosmodrome and center specialists, it can be discovered, for example, that in the "Naryan-Mar" region fragments were collected at 72 points of falling having a total weight of approximately 160 tons. Fragments of stages were collected in Mezen Rayon at 61 points of falling. Four stages and 81

containers with collected fragments (approximately 85 tons of metal) were transported by helicopters to the places of storage; divers extracted 4 stages from the channel of the Koyda River. Incidentally, these stages in the river particularly troubled my fellow citizens in the region and now the river is free.

To be sure, I, probably like many others, was far from euphoria on this score. Work on cleaning up the regions of falling is only beginning and there's an endless amount of such work to do. This involves technology and transport, and naturally, financing. Indeed, according to some data the cost of collection and removal of the stages is four times greater than the value of the collected scrap metal. That is something to think about.

There is a need for fundamental scientific research in this field, a serious national program for ecological protection against the consequences of our space programs.

At the Plesetsk cosmodrome I was told much about these problems by S. Sergeyev, a colleague at the press center. A great expert and enthusiast, he spoke with animation of the establishment in the North of metallurgical miniplants for the processing of space scrap metal. It seems to me that this is a pipe dream, but who knows...?

Ministry of General Machine Building To Undergo 'Radical Transformations', New Space Organizations Formed

LD2009103491 Moscow TASS in English 0956 GMT 20 Sep 91

[By TASS correspondent Vladimir Khrustov]

[Text] Moscow September 20 TASS—In view of the transfer of the many functions of the centre to republics, the country's principal space agency—the USSR Ministry of General Machine Building—is likely to undergo radical transformations soon: Most space-industry enterprises and firms will tranfer to the jurisdiction of sovereign republics.

A Rosobshchemash corporation will emerge in the Russian Federation, the TASS correspondent learned from reliable sources. The KORAT (an acronym for the Russian words Kosmicheskaya I Raketnaya Tekhnika—space rocket technology) will be one of constituent companies.

The KORAT will bring together many large space firms: the Salyut Design Bureau, where all Soviet orbital stations, including "Mir" which is now in orbit, the Progress plant, known for the Soyuz and Energiya space booster rockets and the "Photon" and "Resource" economic research satellites, and other factories and design bureaus.

Glavkosmos and the Energiya Scientific and Production Association—the leading developer of Soviet manned space technology—will apprarently become part of the Rosobshchemash, exercising the rights of companies.

Corporations, similar to the Rosobshchemash, will also come into being in the Ukraine and Kazakhstan—the republics which possess powerful space science and production potential.

U.S. Proposal on Joint Space Defense Examined

LD1610092691 Moscow TASS International Service in Russian 2250 GMT 15 Sep 91

[By TASS correspondent Aleksey Golyayev]

[Text] Rome, 16 Oct—The United States is proposing that the Soviet Union take part in the development of a nonnuclear system of antimissile defense based in space, in the air, and on the ground. The implementation of this plan would be in the interests not only of all the peoples of the USSR, but also the world as a whole. This was stated by V. Shlykov, deputy chairman of the Russian Soviet Federated Socialist Republic [RSFSR] Defense Committee, at an international symposium in the Italian town of Rimini organized by the Pio Mansu Center.

Despite the assurances of the central Soviet authorities about the reliability of control over nuclear weapons in the USSR, he said in an interview with the TASS correspondent, people in the West sometimes express anxiety at the true state of affairs in this area, which was particularly striking in the days following the attempted coup in Moscow. Just as we are, the West is striving to keep this threat to a minimum.

On the question of control in the USSR over nuclear weapons, I personally am basing what I say on the official statements that this control is reliable. However, judging by all accounts, V. Shlykov said, the world is not entirely satisfied with these statements. A degree of anxiety is caused, for example, by the standpoint of Ukraine and Kazakhstan which, insofar as one can judge from the press, intend to keep the nuclear bases on their territory and to have only representatives of these republics serving there.

Of course, all these issues have to be seriously assessed before any conclusions are drawn, the RSFSR representative said. This is a very serious problem which troubles not only the peoples of the USSR, but of the whole world. The Americans, for example, think that it will not in the least promote stabilization on the international scene if missiles, some of which are targeted on the United States, are to be deployed in various Soviet republics among which relations have yet to be finally determined. This is exactly why, V. Shlykov said, they are suggesting that the USSR and all the Soviet republics, regardless of which of them signs the new Union treaty, take part in developing a nonnuclear antimissile defense system. I think it is a very interesting proposal.

Klimuk Replaces Shatalov as Head of Cosmonaut Training Center

LD1909220891 Moscow TASS in English 1745 GMT 19 Sep 91

[By TASS correspondent Rena Kuznetsova]

[Text] Moscow September 19 TASS—A veteran spaceman has been appointed to head the Cosmonaut Training Center. By an order of the USSR Defense Minister, Gen. Petr Klimuk, 49, is replacing Gen. Vladimir Shatalov.

Klimuk took part in three orbital expeditions, the first one in 1973. His second time in space was in 1975. In 1978 he was commander of an international Soviet-Polish crew.

One of the principal tasks of the Soviet space program, Klimuk believes, is to enhance its part dealing with practical applications on earth. "The most important thing is to conduct space research for needs of the national economy, with due regard for its profitability," he believes.

Kazakh Space Agency Responsibilities Not Yet Decided

LD2509230991 Moscow Central Television First Program Network in Russian 2018 GMT 25 Sep 91

[From the "Television News Service" program]

[Text] The common inheritance might become a subject for quarrels between the republics. According to a report of the NEZAVISIMAYA GAZETA newspaper, Kazakhstan has already announced the setting up of its own space agency. To tell the truth, the republic's government does not know what it will be doing. Similar agencies are being formed in Belarus and in the Ukraine.

At the same time representatives of the union structures say that space exploration would be better left with the USSR president, as it is done in the United States and other countries. [video shows launching pads, launch of a rocket, a cosmodrome]

Space Program 'Common Heritage' Could Cause Interrepublic Disputes

PM2709134791 Moscow Central Television First Program Network in Russian 2018 GMT 25 Sep 91

[From the "Television News Service" program]

[Text] [Announcer] The constituent conference of the National Aerospace Museum Fund was held in Moscow today. The idea is to bring together hundreds of museums of this type located in various cities throughout the country. The Fund has set itself the task of reconstructing the historical heritage of our aviation and space science.

At the same time the common heritage may become the subject of disputes among republics. Kazakhstan, for example, has already announced that it is setting up its own space agency. To tell the truth, the republic government is still uncertain what the agency will be doing. Similar ministries are being established in Belorussia and the Ukraine.

At the same time representatives of Union structures are saying that it would be better if space exploration were left under the jurisdiction of the Union president, as is the case in the United States and in other countries. [video shows launch pads, a launch of a rocket, cosmodrome]

Criticism of Policy of Preference for Foreign Cosmonauts

927Q0004A Moscow LITERATURNAYA GAZETA in Russian 2 Oct 91 p 7

[Article by Valeriy Sharov, LITERATURNAYA GAZETA correspondent: "Space Trade—From the Pioneers of the Universe We Risk Transformation Into Cheap Space Carriers"]

[Text] In Moscow, in the square at the Riga market, there is a sculpture, a man with a satellite in his hand, which has become virtually forgotten. The symbol of our first space victory, with the hubbub of the nationally known center of trading flourishing around it, has looked more and more dismal and incongruous. The paint flaking off, bird droppings on the head, the antennas of the space vehicle broken off.... And all around the air is filled with the smoke from mutton roasted on spits, accompanied by a brisk trade in overseas goods, the deceit of gamblers and confidence men. Time has created new symbols....

Close familiarization with Soviet cosmonautics for a person far from space causes great surprise. It is simply astonishing: how do complex spaceships fly successfully in a country with an economy in agony and an industry in collapse? Possibly the first article from Zvezdnyy Gorodok should be written about how it happened that I—a journalist—came to be here as a USSR cosmonaut candidate. I will still write it. But not today. Because when the financing of Soviet space programs is being reduced, and manned cosmonautics itself is under the threat of a shutdown, this image—space and the market—will not leave me.

The Zvezdnyy Gorodok of the era of perestroyka received us (the six journalists selected for training for flight in the "Mir" station) with a dwindling assortment of goods in the once-refined local stores and a number of foreigners in its streets and in center classes increasing directly before our eyes. The resolutely adopted course toward the commercialization of Soviet space flights had been transformed into life. We exchanged greetings with Japanese, Englishmen, Australians, Germans and Frenchmen who were in training for their launchings. And at the same time we noted with joy the first traces of

worthwhile receipts of foreign exchange in the instructional base at the center: a Japanese camera, a modern personal computer.

Time passed. We mastered celestial navigation, flight ballistics, control of the spaceship complex and its life support system. But it is more difficult to comprehend the nuances of life within the detachment, the criteria for assignment of candidates to an upcoming flight, and in particular, the interrelationships among different "space" departments. And the differences between "us" and "them"—the cosmonaut candidates from abroad—have become more and more evident.

Each of them immediately upon arrival in Zvezdnyy Gorodok were provided an individual three-room apartment with international telephone service.

"In Tokio I had a very small one-room apartment," said the Japanese Rioka Kikuti in sincere surprise, "but here—such mansions. That's very good...."

In actuality, it is much better. We also were housed fairly well: in well-built dormitories for crews with two men per apartment. A telephone for communication with editorial offices—but only those in Moscow—one telephone for all of us. The service vehicles of the training center are always at the disposal of the foreigners; we also have these services when we could get them: failures in transportation have been the rule, despite the letter of guarantee of remuneration.

It would not be worthwhile to touch on such details if they applied only to the journalists—people completely new in the cosmonaut detachment. But all of Zvezdnyy Gorodok has become the victim of the "foreigners factor."

When food coupons and cards were introduced throughout the country, here with the last strength available attempts were made to hold on without these attributes of smashed socialism. They could not hold on—the coupons had to be introduced. It is true that the foreign guests in no way suffered from this and probably did not even notice the change. They do their business in a special store for Heroes of the Soviet Union, that is, even prior to flight are put on a par with people who evidently merited such privileges due to their self-sacrificing work in space.

The cosmonaut training center begins with the flight dining room. Each morning we go there for breakfast. All of us without exception—both the recruits and the Heroes of the Soviet Union who have already flown in space and instructors, we all sit down in one rather modest hall. Here there is communication, like in a club: there is an exchange of news and jokes are tossed back and forth... The foreigners, members of this same group, preparing for flights in Soviet ships, file into a separate room, with a separate entrance, with a carpet on the floor and a multilevel crystal chandelier overhead. Even their dishes are special, with decorations.

It would be possible to ignore this as well, but at Zvezdnyy such details are perceived as a symptom of something more serious. Here you have to recall the words of the Bulgakov hero spoken about a foreigner in Torgsin: "To be sure... it is all packed with foreign currency, but is it ours, ours? I am bitter! Bitter!"

And I am outright bitter. As you could perhaps understand somehow in the Intourist hotel or in the hard currency store where they and we are hopelessly separated by a historically developing economic inequality, absolutely incomprehensible and intolerable in the course of preparation for an international space flight. Why is it that people who will breathe from the same oxygen tank, use a common, pardon, sanitary facility and identically risk their life there in space, dine under different conditions down here?

Thank heavens, the kitchen and the food products for the time being are still the same for all. But then there's an obligatory part of general space training, survival for two days under arctic tundra conditions. For some reason all the foreigners undergo this training under extremely easier conditions...near Moscow. As if in the case of an emergency landing of the ship in the Far North region in winter a foreign crew member will miraculously encounter Intourist guides there.

But the principal privilege of a hard currency cosmonaut is that he knows the date of his flight from the very first day of his presence at Zvezdnyy. His training is fitted into a little less than one year, whereas our lads may, without any guarantees, knock around here up to 15 years!

The short deadlines and the clearly defined training conditions are determined by contracts in accordance with which extravagant (in comparison with our extremely modest requirements) sums come from abroad. For this money we give the foreigners a space seat which is made free for them on almost every flight. These flights, without intending to be clever, are now even called: "Japanese," "British," "Australian"...

It already seems to some that our cosmonautics has finally latched onto that gold mine which will solve all the problems facing us: recompense the people for the billions invested in it and ensure its comfortable existence.

Illusions! Our present-day space policy is oriented on a relentless pursuit of foreign exchange and frequently ignores our own scientific, humanitarian and other programs (other than military). Look how a foreign reporter and a foreign chemical engineer have already flown in our ships. An engineer and astrophysicist are making ready for flight. Among the Americans more than half the astronaut detachment is made up of such scientists. But in the Soviet cosmonaut detachment there is still not a single representative of a fundamental scientist. Only a year ago did we journalists succeed in coming here. And we still do not know when there will be a flight or if it will occur at all.

And already G. M. Strekalov, USSR flier-cosmonaut, twice HSU, has declared in an interview that many cosmonauts are capable of solving those problems which journalists have set before themselves in space.

So it comes down to this, that in general none of the specialists are coming any closer to flights; everything will be done for them by professional cosmonauts. But how will it be done and what will be the results of this work? Indeed, up to now the functions of the cosmonauts in the scientific experiments in space stations have not gone beyond the scope of the tasks of a laboratory worker.

Nevertheless, while accepting the idea of flight of a Soviet journalist, the respected Gennadiy Mikhaylovich expressed the following wish: "Let him go through our entire process from beginning to end.. Let him, like many of us, at the last moment before launching be shoved aside, let him even fly unsuccessfully...."

And this is said by a man himself burning for the launching of a spaceship! But to the Japanese journalist T. Akiyama, with whom G. Strekalov visited on the "Mir" station, he expressed himself differently. And he said outright: a Soviet journalist would not have been of assistance in the flight, "although the Japanese assisted."

Many Soviet academic or branch institutes are dreaming of a place on a spaceship for their own scientist or their own scientific program. But where will they get such money, the 13 million rubles for one seat on a flight? No one instructed them to place demands on themselves and now we have competitors with dollars. Space seats are being sold right and left for foreign exchange. The immediately upcoming plans call for flights of citizens of Spain, China and even an American, winning a lucky ticket in the lottery. Just pay up, sir. A taxi is at your service!

Sold up to the point that the scheduled commercial flight of the Englishwoman Helen Sherman ended as a great commercial failure and in human tragedy. The newspaper MERCHANT assessed the actions of our space entrepreneurs as a violation of all norms of business ethics. In the pursuit of maximum profits at the last moment they replaced their business partner and as a result there was a loss of about six million dollars. In the opinion of a number of informed British sources, this behavior of the USSR Glavkosmos in the last analysis was responsible for the suicide of Mark Reggit, one of the principal initiators of the original project. Abroad all interested parties receive commercial information instantaneously and such an ill-starred gamble will probably be reflected in the concluding of future contracts. Even without this our cheap space services (the services of Americans are three or four times more expensive) will have a still lower payoff.

But these are financial expenditures, which can be added up in specific monetary units. The moral losses are more serious and it is impossible to reckon them. When a noise was raised in the press due to the sale to the Japanese of the first flight of a journalist into space, one of the Soviet ministers proposed to pay the neccssary sum in foreign exchange for our flight. However, this was pounced upon—our national money is being squandered! And soon thereafter the Ministry of General Machine Building, our principal space department, lightly rejected a half-billion rubles allocated by the Ukrainian Industrial Construction Bank for the training of the six Soviet journalists already selected. They said they would not take money for such a worthwhile undertaking (our flight is being prepared under the motto "Space - Children."

And we have already experienced what it means to do serious things without money, even when all around they think only of hard currency. There are no rights, nor guarantees nor even insurance in the event of an accident during training or during a flight itself. And you pay for the hotel out of your own pocket and there is no hint of a launching date. And in essence such "philanthropy" is attributable to reluctance to change the slavish situation in we all have lived for more than 70 years and in which people are very easy to control, suppressing any initiative, which holds true with respect to the entire country, the Soviet cosmonaut detachment or the six journalists in it.

"Aren't you putting a roadblock in your road to space?" asked my colleagues in the editorial offices when I shared with them my thoughts about this article. "Maybe you shouldn't...."

Yes, I should, because I entered the cosmonaut detachment as a result of the first nationwide open competition in our country. I am not indifferent to the fate of our cosmonautics or to the fate of the country. And should I begin to think how this or that which I say will reflect on me and what penalties may follow, there is nothing to be done. If, however, some penalties follow right away, there is double nothing which can be done. I don't doubt: without a change in attitude toward ourselves, toward the people responsible for this attitude, Soviet cosmonautics will not survive. What will occur—escape from subordination to the military departments and total demilitarization, contract working conditions or something else, time will tell. But the most important thing to be determined is: for whom and for what will it exist?...

The Moscow City Council resolved the problem of the ill-fated Riga market simply and rapidly: on a single day it removed the stalls and expelled the petty hawkers and cheaters. And now the sculpture "Man Holding a Satellite" stands with his legs resting on some new base, true, as before, dirtied by bird droppings and with broken-off space vehicle antennas.

I am against such measures with respect to the entry of Soviet cosmonautics into a market economy. Yes, we must actively attract foreigners to cooperation and earn foreign exchange, as other space powers do. In order both to recompense the Soviet people, investing so much in it, and to ensure its existence and development and

transfer of the invaluable experience which we have accumulated to world science. But all this must be done with great intelligence. Otherwise from the pioneers of space with our own original technology we will finally and irreversibly be transformed into simple space carriers who will be concerned only about the proper operation of our machine and choice of a profitable client. And others will go, excuse me, fly in it and develop their own space programs.

Future of Soviet Space Program Said to Depend on Republics

LD0210035191 Moscow Central Television First Program Network in Russian 1900 GMT 1 Oct 91

[From the "TV Inform" newscast]

[Text] Tomorrow, at the invitation of Kazakhstan's President Nazarbayev, those attending the Alma-Ata meeting fly to the Baykonyr cosmodrome, where they will witness the take-off of the Soviet-Austrian space crew. Viewers will see a live report on the take-off in the "Utro" program. At the moment, our correspondent, Petr Orlov, is there. [video shows distant shot of a booster rocket being transported along a railway track]

[Begin recording] [Orlov] Space research, which ideally would have drawn our equipment and technology up to a modern level, has itself turned out to be a victim of the collapse and redivisions that embrace a vast area of the former Union. The fate of fundamental and practical work on the Mir space station, distant space exploration, and the defense orbital programs up to and including the communications satellites that have to be changed every year, depends on the wish and the ability of the sovereign republics to agree among themselves. Let us hope that that process has started today in Alma-Ata. [video shows shots of Mir; views of the Earth from space; rocket on launch pad]

Clearly, space research will not be a priority issue during the talks, obviously following such issues as the sharing of the external debt, customs barriers, and territorial questions. The Baykonyr cosmodrome is a different matter. It is a problem of former Soviet property.

[Unidentifed man] All enterprises, institutions, and organizations, irrespective of their departmental subordination in the past, switch over not only to the jurisdiction but to the state administration and leadership of the government administrative bodies of Kazakhstan.

[Orlov] In practice, though, the situation has hardly changed at all. Financing comes from the previous source.

[Unidentifed Air Force officer] Only the Ministry of Defense.

[Orlov] To all appearances, everyone who previously launched space vehicles from here will have to reach an agreement with Kazakhstan. They are the large communications satellites, Energiya, Buran, and all the manned vessels, including international crews like the Soviet-Austrian crew that flies off to the Mir station tomorrow, with the participation of a Kazakh cosmonaut. [video shows a hangar with a space vehicle; the Soviet-Austrian crew; rocket on launch pad] [end recording]

Incidentally, Kazakh cosmonaut Takhtar Aubakirov has said that in the international crew he will be representing Kazakhstan.

Kazakh, Austrian Leaders Meet Press at Baykonur

LD0210185791 Moscow TASS International Service in Russian 1114 GMT 2 Oct 91

[Excerpts] Baykonur, 2 Oct (TASS)—The Soyuz TM-13 spacecraft was launched here today. [passage omitted] Among the guests on the viewing platform of the launch facility were Ivan Silayev, chairman of the interrepublican economic committee; Franz Vranitzky, federal chancellor of the Austrian Republic; Nursultan Nazarbayev, president of Kazakhstan; and leaders of the republics who arrived here at the invitation of the Kazakh president after spending time in Alma-Ata discussing the treaty on an economic community.

Having seen off the international crew, Nursultan Nazarbayev and Franz Vranitzky organized a news conference for Soviet and foreign journalists. How the sovereignty of the republics can be combined with general space research, the possibility of only one department running such a powerful and costly launching site as Baykonur, the continuation of international flights, and how sovereign Kazakhstan will start to establish international contacts—these issues were the subject of discussion at this news conference.

Kazakhstan is ready for any form of cooperation on a mutually beneficial basis—this viewpoint was shared by practically all participants in the meeting. Doubtless, subsidies from the country's budget will be needed. It was particularly emphasized that military launches from the launch site will not pose any danger to other countries, regardless of the jurisdiction of Baykonur itself.

Silayev Advocates Space Coordinating Center 'Resembling NASA'

OW0310135691 Moscow INTERFAX in English 1130 GMT 3 Oct 91

[Transmitted via KYODO]

[Text] More effective space exploration by the USSR requires the formation of a common coordinating center resembling NASA. The statement was made by the acting Soviet premier Ivan Silayev at Baykonur cosmodrome. He attended the Wednesday [2 October] launching of a spaceship carrying a crew consisting of a Russian, a Kazakh and an Austrian. The American

shuttle makes regular manned flights, while the Soviet Buran has made just one unmanned flight. This, Silayev said, is one of the results of the dispersal of forces involved in space studies in this country.

"This is why our new economic community should have its own NASA", Silayev said. He described as a major mistake the division of the air and space industries, which are one and the same industry elsewhere in the world. "In my new capacity I want to carry out the project which I had in mind back when I was the Minister of the Soviet Aircraft Industry—to combine the two in an aerospace industry", Silayev stressed.

Space Program Cuts Anticipated

PM0810081591 Moscow Central Television First Program Network in Russian 0630 GMT 5 Oct 91

[From the "Television News Service" newscast]

[Text] [063610] [Announcer] As from today an international space crew is orbiting the Earth. It comprises the Russian Volkov, the Kazakh Aubakirov, and Austrian citizen Viehboeck.

Meanwhile, the new space flight has once again focused world attention on the Soviet space program. It has to be admitted that despite the successful work of the current space crew, some general comments are less than flattering. For example, the British newspaper THE TIMES writes citing undisclosed political sources in Moscow that cuts affecting a number of Soviet space programs are to be announced within the next few weeks. According to the newspaper, a decision has already been made to drop the program for building Buran space shuttles and for launching a new space station, Mir 2. The newspaper cites experts as saying that this could be taken as the Soviet Union's renunciation of its status as a space superpower.

'Intersputnik' to Pursue Commercial Ventures

LD2010170991 Moscow TASS International Service in Russian 1608 GMT 18 Oct 91

[By Kaztag correspondent Vladimir Cherkizov]

[Text] Alma-Ata, 18 Oct (TASS)—The main result of the 20th session of "Intersputnik", which ended in the Republic's capital today, was the adoption of a decision on greater commercialization of this international space communications organization.

Previously, satellites were launched free of charge or for a token payment. Now the time has come to put space cooperation onto a market footing. According to specialists, this way of organizing affairs promises considerable benefits for our country. Even the design and development of "Express," the new generation of communications satellites, will be financed by the organization's participants themselves. They will receive the right to acquire full ownership or to lease them. The range of services provided by our ground stations is being widened considerably.

The new policy has been approved not only by the countries participating in "Intersputnik", for it is also receiving international support. Evidence of this is the accession of the organization's 16th member, Syria, and a memorandum of cooperation with the "Intelsat" satellite communications consortium. Germany has declared its desire to become the GDR's heir in "Intersputnik". An accord has also been reached with U.S. firms to develop a joint television and telephone bridge between America and Europe.

Future of Bayakonur Cosmodrome, Space Program Viewed

927Q0001A Moscow IZVESTIYA in Russian 4 Oct 91 p 4

[Article by B. Konovalov, IZVESTIYA scientific commentator: "How Will We Split Up Baykonur?"]

[Text] **On 4 October the Soyuz TM-13 vehicle should dock at the orbiting complex Mir. Everything is normal in the orbit. Let us revisit the issue of the fate of our domestic space exploration which, in essence, is being decided at present.**

The launch at Baykonur proceeded according to a fine-tuned pattern, but the atmosphere was unusual nonetheless. Everybody was concerned about the future of space exploration. It was characteristic that not a single foreign correspondent from among a large contingent that came to the space launch complex asked a question at the official press conference of the State Commission, whereas Soviet correspondents pressed their attack continuously.

Is it true that the program for manned space flight is being cut back abruptly? Is it correct that we intend to sell the Mir orbital station to foreigners? Will Kazakhstan extend its jurisdiction to the Baykonur space launch complex, or will it remain an all-Union facility? Everybody repeated various versions of these and similar questions.

The sovereignty of the republics, the proclamation of independent states, and the fluctuations and uncertainty with regard to the drawing up of the Union budget will certainly affect the future of space exploration. The USSR Ministry of General Machine Building, which produces missile and space vehicles, is living through its last days in the present format. It will apparently be divided into Russian and Ukrainian corporations: The bulk of the aerospace industry is concentrated precisely in these two republics. Kazakhstan has already announced the formation of its own Space Exploration Agency. However, only Russia is in a position to continue space research on its own. The Ukraine does not have space launch complexes. Kazakhstan does not possess an aerospace industry. Other republics have

invested their funds in this industry and in the construction of Baykonur, and are entitled to demand that their interests be safeguarded. Apparently, the leaders of the republics should resolve these issues.

However, the journalists succeeded in learning certain things.

Yu. Koptev, deputy minister of general machine building, stated firmly: "Space exploration has not existed to date in any country without state financing, and ours will not survive either."

Yu. Semenev, general director of the Scientific Production Association Energiya, also firmly guaranteed that the Soviet-German and Soviet-French flights, which like the Soviet-Austrian flight are operated on a commercial basis, will take place. He sees a way out in securing greater commercial independence for the space industry and perhaps in creating an international association for the subsequent operation of the Mir station. This association may receive loans in hard currency, turn them into rubles, and subsequently provide substantial aid for the development of manned space exploration with this money. He maintains that space exploration will survive.

Ye. Yezhikov-Babakhanov, first deputy prime minister of Kazakhstan, confirmed that all enterprises of the republic, including those located in the compound of the Baykonur space launch complex, should come under the management of the Kazakh SSR [Soviet Socialist Republic] government. At the same time he was forced to acknowledge that Kazakhstan is not in a position to operate the Baykonur space launch complex on its own.

Colonel General V. Ivanov, chief of the Space Units [as published] of the USSR Ministry of Defense, stated firmly that all Baykonur launch complexes will remain under military jurisdiction.

Everybody evaded questions concerning the amount of funds already invested in Baykonur. Yezhikov-Babakhanov said that it has been neither one, nor two, nor three billion. Of course, the numbers are much greater. One launch pad for launching Proton rockets costs about 1 billion rubles [R]. And they have four of them here. The launch complexes for Energiya rockets are much more sophisticated and expensive. One runway for the landing of the Buran vehicle costs a "pretty penny," going into billions. If Kazakhstan privatizes all of this we could hardly call it a wise step. At the same time, it is clear that Kazakhstan should receive some share of funds by virtue of operation of the giant site, at least in order to improve the social and housing situation at the space launch complex.

The complex was shrouded in secrecy for a long time. We journalists could not even drop a hint that the space launch complex was operated by military specialists. There were censors at the local teletype, as well as at the other end in Moscow. Even the history of Baykonur itself still remains hazy to this day.

Academician V. Barmin, chief of the Launch Complex Design Bureau, told me that when the issue of a site for launching intercontinental missiles arose, three possible sites were discussed. The first was in the area of Makhachkala, with used stages falling into the Caspian Sea; the second was in Mordovia, where the cutting of large forested areas was proposed; the third site was in Kazakhstan. The third site, which was the worst from the point of view of climatic conditions, was opted for. This is a semidesert, with icy winters and scorching heat in summer, but the area is sparsely populated.

The very name Baykonur also came along out of secrecy considerations. The location of the launch had to be indicated in order to officially register Gagarin's flight. The station of Tyura-Tam, next to which the present city of Leninsk with 100,000 inhabitants was located, was considered a great secret. So, somebody pointed his finger at the map and indicated the settlement of Baykonur, which is situated about 400 kilometers from here in a straight line. This is how this settlement became famous, although it has nothing to do with space—except that this is approximately where the used stages of rockets fall. It seems that the city of space explorers was initially called "Tashkent-50," and later Zvezdograd, and subsequently Leninsk. In the process, the censors alternately allowed and prohibited us from mentioning it. Syrdarya, which flows through here and at one time was deep, was named an abstract river. This is why many people believe justifiably that the name of Baykonur, under which the city is known to the entire planet, should be officially given to it. This will help the city to transform itself gradually.

For now, it bears the imprint of nondescript military settlements with their primitive architecture. But the city wants to be worthy of its worldwide fame. The situation is beginning to change. In August, the first group of American tourists visited; a branch of the West German company Burda-Moden will open soon. There are parties willing to build a modern hotel complex here. The city has many needs. Opening up and eliminating unnecessary secrecy may help it, as well as our space exploration in general.

At the postlaunch conference with Austrian Chancellor F. Vranitzky and Kazakh SSR President N. Nazarbayev at Baykonur, confidence was expressed that space launches from the land of Kazakhstan would continue. Replying to a direct question from IZVESTIYA, President N. Nazarbayev stressed that Kazakhstan does not intend to assume responsibility for the command and control of the Strategic Rocket Forces on its territory. It is just that, unlike the Ukraine, Kazakhstan believes that the redeployment of nuclear missiles to Russia will cost too much. It is precisely due to this that the republic does not intend to proclaim itself a nuclear-free zone. The president noted that he has always adhered to the policy of preserving the Union of Soviet Republics, and does not intend to change his position.

Closer Ties to European Space Program Viewed

927Q0002A Moscow IZVESTIYA in Russian
8 Oct 91 Union Edition p 2

[Interview with Yu.N. Koptev, deputy USSR minister of general machine building and president of the Kosmos concern, by IZVESTIYA science correspondent B. Konovalov; place and date not given: "A Roof in Space for the Common European Home—Now We Can Build It Together"]

[Text] **The epoch of great state upheavals has also affected our space program, whose future will have to take into account the formation of sovereign republics. The USSR Ministry of General Machine Building, engaged in the production of rocket-space materiel, is being reorganized into republic corporations consisting of a number of concerns and associations. One of the most powerful of these will be the Kosmos concern, whose composition will include all the leading organizations of the space industry operating in Russian territory, with the exception of the renowned Korolev firm, presently called the Energiya Scientific Production Association. It will apparently become an independent concern. We asked Yu.N. Koptev, deputy minister of the USSR Ministry of General Machine Building which exists for the time being, and who was elected president of the Kosmos concern, to share with us his thoughts with respect to how the USSR space program intends to survive these difficult times.**

[Koptev] Our state or community of sovereign states must realize that if the integral industrial-space complex we presently have is destroyed, this will destroy as well the vital activity systems of television, communications, meteorology, and navigation. Exploration for useful minerals will be impeded. Observing and taking stock of the condition of our lands and forests will become more complicated, as will exercising ecological control over our territories. Defensive strategic programs which utilize space technology will fail. No matter what degree of independence the present sovereign republics acquire, they must objectively maintain an interest in the utilization of space technology for economy, fundamental research, and defense. Therefore, along with the commercialization of the space program, it is absolutely necessary that budget financing for it also be maintained. No single state in the world today can do without this. But in our case, this sound and far-reaching policy is being replaced by endless unsubstantiated discussion about the "high cost" of space. Even though about 22 billion rubles [R] have been invested in the fixed assets of our industry over the entire period of existence of cosmonautics, annual expenditures for the development and maintenance of the life-functioning of all of cosmonautics, including defense aspects, do not exceed R6 billion. And taking real inflation into account, these expenses are depreciating by a factor of two. For comparison purposes we can say that R80 billion are allocated annually on agriculture, the result of which everyone knows.

But irresponsible discussions do their work. In 1991, of those funds which were approved by the USSR Supreme Soviet within the budget framework for civilian space use, already about 30 percent has been arbitrarily "chopped." We do not know what will happen next year. What is in fact taking place right now is the destruction of one of those few of our industrial branches which is capable of standing up to competition on a global level.

[Konovalov] It has become customary today in all our difficult situations to expect that "we will get help from abroad." A joint Soviet-Austrian space flight is presently in progress. Perhaps the solution to the problem lies in expanding international cooperation and the commercialization of the space program.

[Koptev] Unfortunately, in our sphere of activity, instead of helping us, the West is today trying to trip us up. The well-known Cocom [Coordinating Committee for Multilateral Export Controls] restrictions are in effect which prohibit export of advanced technologies to the USSR. The clearest example of the effectiveness of these restrictions can be seen in the ban imposed by the United States on the export back to the USSR of our very own space nuclear reactor Topaz. Not a single satellite, if it contains just one U.S. part or if U.S. technology was used in its production, can be launched by a Soviet rocket from our cosmodromes. And the issue here is not secrets which we might allegedly steal. It is just a more cultured method of denying us entry into the world rocket-space market. When necessary the Americans are well capable of getting around all the restrictions. The so-called "black box" technology has been developed which enables countries to maintain control over their satellites and instrumentation throughout the entire journey, from time of entry into our country to launch into space. Thanks to this technology, at a time when we are in no way interfering in others' designs, the American device TOMS [Total Ozone Mass Spectrometer] was launched on board our weather satellite from the Plesetsk Cosmodrome by the Soviet Tsiklon rocket to study the Earth's ozone layer. And so it is not help we need from the West, but simply that they recognize us as equal commercial partners.

[Konovalov] Bitter though it may be to admit, it is after all because of the unrestrained USSR militarization that the restrictions were introduced by Cocom. Today the appearance of our country is changing. Democratic republics are appearing and the unnecessary degree of secrecy in defense spheres is disappearing. Why shouldn't Russia and the Ukraine, having a space industry, embark upon closer cooperation with the European Space Agency (ESA), perhaps even become associate members?

[Koptev] Here again things are somewhat complicated. We are engaged in successful cooperation and will continue to be so engaged. In any case, we are seeking contacts on a mutually beneficial basis. But ESA members want the funds they have invested to be returned to them in the form of orders for the science and industry of

their own countries in the implementation of space projects. No one is about to reduce their own work space for our sake.

[Konovalov] But broader and more involved participation on the part of Russia or the Ukraine would make it possible to reduce the cost of projects. And this could constitute our contribution to the ESA. Coming up in November of this year the ESA will hold an important session in which the fate of many projects will be decided. Perhaps we could introduce proposals beneficial to the ESA?

[Koptev] Objectively speaking, it would be advantageous to the ESA to effect more involved cooperation with us. Dissipation of resources, "reinventing the wheel" with respect to designs and technology we have already fashioned not only makes things more expensive, but—and this is no less significant—draws out the time frame of implementation of European projects, causing some to become obsolete. Our active participation in such projects as building the powerful Ariane-5 rocket, the multi-use Hermes space ship, and a general-purpose near-Earth space platform would sharply accelerate the program and provide significant economic savings. And this could be seen as our contribution, the equivalent of money. For our part, we are also prepared to become more open, to establish joint space organizations with the European countries and afford the opportunity to acquire shares in our enterprises. With cordial relations, all this is possible. And indeed, perhaps it is with a roof in space that construction of the common European home will begin.

NASA, ESA Cited as Space Program Models

927Q0003A Moscow KOMSOMOLSKAYA PRAVDA in Russian 8 Oct 91 p 2

[Article by V. Postyshev, candidate of legal sciences, member of the International Institute of Space Law: "Whose Grass Is It Outside the Porthole? Russia May Be Left Without a Space Launch Complex, and Kazakhstan Without Rockets"]

[Text] The time has come to ponder where funds for space exploration come from and to whom the Mir orbital station Baykonyr and the satellite and rocket plants belong.

These quite ordinary economic and legal issues are now being resolved at the highest political level under the influence of interests which are not "space-related" at all. For now, it is hard to expect that Moldova and Transcaucasia will take part in space programs. Belarus and the Central Asian republics would not mind satellite communications either, but they will hardly be able to finance space science and industry.

What is at issue? Soviet space exploration embraces about 2,000 enterprises and organizations. It accounts for 1.5 percent of the gross national product. More than 10 million people (including support personnel and family members) work in space science and industry.

How is such a facility to be split up? A great many problems will develop if it is done on "the principle of soil," as is now the case with enterprises under Union jurisdiction. First, the key components of space systems, the satellites, are located in space beyond the limits of state jurisdiction. This is what international law says. Second, the space infrastructure was created as an all-Union element. It cannot be sliced into pieces. The Baykonyr space launch complex will be of no use if Russia refuses to launch its satellites from it due to emerging national partitions. It will be hard for the Ukraine to continue work on the efficient Zenit booster rocket if it is not granted free access to the launch pad in Kazakhstan. All space programs are impossible without use of the Flight Control Center located in the RSFSR [Russian Soviet Federated Socialist Republic]. A promising draft to set up a space launch complex for Soviet booster rockets in Australia attracted 40 organizations from various regions of the country in the capacity of co-executors. Third, as a united subject of international law, the USSR has a number of substantive rights and obligations following from interstate agreements on space. The Union is represented in United Nations organs engaging in space issues and in international space organizations. It has been allocated five orbital positions and radio frequencies for satellite communications. The USSR is responsible for space operations and possible losses to third countries.

Nonetheless the republics are separating from one another. Upon whom will the space umbrella, once erected through joint efforts, come down? The answer is as clear as can be: on Russia. Close to 90 percent of the enterprises of the aerospace complex are located in its territory. Virtually all of them are very weak economically. However, a giant size (up to 80,000 employees) and overblown secrecy are characteristic of them. Space NPO's [scientific production associations] are absolutely not suited for a market economy. Wages alone in the sector are subsidized in the amount of 1.5 billion rubles annually.

Under current circumstances, it would be feasible to set up a Russian space agency—a special organ in the system of RSFSR executive power responsible for space exploration, and at the Union level—a coordination council for implementing space programs supported by the republics on a contractual basis. In other words, the transformation of the USSR into a complex state structure necessitates a two-tier system of managing space exploration: in the RSFSR on the pattern of the National Aeronautics and Space Administration (NASA) in the United States, and at the Union level on the pattern of the European Space Agency (ESA).

Both models have their advantages. Strictness in the pursuit of national interests is characteristic of NASA. The latter makes it possible to draw an extensive circle of scientific and industrial organizations from various

countries into implementing space programs. Such programs are financed 70 percent or more by foreign participants. The ESA is a well-tuned form for cooperation among sovereign states in the area of space exploration.

How will space cooperation develop? The republics will obviously join programs which they find sufficiently attractive. Who will take the first step along this path? There is nobody else to do it but Russia. Otherwise, it can expect additional millions of unemployed and the loss of the elite cadre personnel and its place among the leading scientific-technical powers.

If properly managed, space science and industry yield tremendous effect. The funds invested in them are recouped within five to seven years. Space communications are six time cheaper than regular cable communications. The research of the natural wealth of the earth and the sea from space generates seven rubles in returns per every ruble of outlays. On the scale of a country such as the RSFSR space systems are the only reasonable means for TV and radio broadcasting, metrological, geodetic, and cartographic services. Profitable production in space of unique materials for radioelectronics, medicine, and other sectors is very near. At present more than 120 countries of the world invest funds in space exploration. An international space market is developing fast. Its annual volume exceeds $50 billion. According to various estimates, by the year 2000 it will come to between $100 and $200 billion.

The stars are becoming more and more distant as the former USSR divides up space assets.

Problems Arising From Kazakhstan's Claim to Baykonur Cosmodrome Emphasized

927Q0026A Moscow IZVESTIYA in Russian 19 Oct 91 Union Edition p 10

[Article by M. Arkhipov, lieutenant colonel: "A Cosmodrome is Not Disposable"]

[Text] At Baykonur a holiday spirit prevailed on the occasion of launching of the first representative of Kazakhstan into space. But for some reason a feeling of resentment prevailed in the spirit of many of the specialists arriving this time at our main space harbor. Perplexity was expressed even by Western specialists who have a good handle on the economic situation. All the conversation dealt with the decree of N. Nazarbayev, the president of Kazakhstan, on the nationalization of the cosmodrome....

With one stroke of the pen more than a large enterprise was transferred to the jurisdiction of the republic. The cosmodrome was brought into existence by the best minds and hands of the entire country and was correctly regarded as the property of the entire state. Baykonur was founded 36 years ago in Kyzl-Orda Oblast in an area measuring approximately 80 x 120 km. But the cosmodrome is not just Baykonur itself. The network of centers and stations of the command-measurement system of space units of the USSR Ministry of Defense, directly controlling all space vehicles in orbit, extends for thousands of kilometers to the east of Kazakhstan to the Pacific Ocean itself. In this network only one measurement point is situated in Kazakhstan, not far from Lake Balkhash. In addition, the operation of manned vehicles beyond the boundaries of our territory is tracked by the ships of the USSR Academy of Sciences. What will be done with the cosmodrome by Kazakhstan, which is obviously unprepared for independent launchings into space?

In analyzing the claims of Kazakhstan to the cosmodrome it becomes clear that under the conditions of a breakdown of the USSR cosmonautics is being made ready to be "put up for auction." Although the principal space facilities are concentrated in the territory of the RSFSR, many highly important components of the branch, such as the production of the "Zenit" and "Tsiklon" boosters, is carried out in the Ukraine and the component parts are produced in virtually all republics of the former union.

Russia has the northern cosmodrome Plesetsk, the busiest, where 75 percent of all space vehicles are launched. Without question it also can be reoriented to manned launchings. But will Russia be able to reconstruct the operation of industry? A debatable question. After all, the old economic ties have been virtually broken and the developing market economy is familiar to us only on the basis of the prices in the commercial stores and at the commodity-raw material exchanges. Accordingly, such a reorganization of space activity will inevitably require additional capital investments greater than now by a factor 2.5-3, for the time being still enabling Soviet cosmonautics to keep afloat.

The withdrawal of the Ukraine from the union also imposes restrictions on space activity in connection with a reduction in the number of measurement points which monitor flights and send commands to space vehicles, receive and analyze telemetric information in nonstandard situations. Thus, according to the estimates of Western experts, the reliability of our manned space flights under the new political conditions may be extremely precarious.

Cosmonautics is one branch of human activity which does not give an instantaneous yield. Its dividends will come in the future. Computations show that a long-term space program for the development of space systems for economic and scientific purposes and in the interests of international cooperation can bring about 8 billion rubles of profit with total investments of 4 billion.

The striving of the individual republics to drag cosmonautics under their national roofs is further fraught by the danger that carrier rockets can be used as a means for the delivery of nuclear and other types of weapons to any points on the Earth. Under conditions of breakdown of

the former union republics into "nuclear" and "nonnuclear" cosmonautics may become a point of unresolvable conflicts.

The government of Kazakhstan, understanding the full significance of the cosmodrome and trying to bring it under its jurisdiction, has established a National Space Agency which it is too early to consider an analogue of the American NASA. The Kazakh Space Agency until now does not have either its own program or the funds to maintain Baykonur. Even Ye. Yezhikov-Babakhanov, the vice-premier of the republic, could not explain what this agency plans to do. However, the Russian leadership, attempting to regularize cooperation among the republics, is ready to yield Baykonur to Kazakhstan without giving thought to how long its functioning will continue. The cost of the cosmodrome (to April of this year) was estimated at 3.5 billion rubles and the annual expenditures on its normal functioning were about 400 million. Is it necessary for the Kazakh people, taking the shirts off their backs, to thrust the next spaceship into the sky?

Today, as never before, there is a need for national wisdom in solving problems related to national defense of the country and development of its key element: cosmonautics.

Military Joint-Stock Company Created

LD0411142791

[Editorial Report] Moscow All-Union Radio First Program Radio-1 Network in Russian at 1600 GMT on 2 November carries a 17-minute feature presented by Kim Kukhovlev on a new joint-stock company, the Military-Industrial Investment Company (Voyenno-promyshlennaya Investitsionnaya Kompaniya), whose constituent assembly was held recently in Moscow.

Kukhovlev begins by saying that the defense sector is attracting the gaze of the country's business community and this new company will engage in military and investment business. It has a long list of founders, including the Military-Industrial Stock Exchange, the Russian Commodity and Raw Materials Joint Stock company, the Moscow Central Stock Exchange, the Russian Commercial National Bank, the Central Scientific Research Institute of Machine-Building, the Khrunichev Works, the Pleshakov Scientific Production Association, the Congress of Stock Exchanges, the Economic News Agency, the (Kamey) joint stock company, commodity and stock exchanges, research and development institutes, the Dzerzhinskiy Military Academy, the Ministry of Railways Central Communications Center, and the VNP-Tsentr joint stock company. Kukhovlev includes in the list "Army unit No 57275-1." He goes on to say: "That's no military secret now."

Next, Kukholev interviews Aleksey Vladimirovich Gribkov, chairman of the VNP-Tsentr joint stock company and member of the board of the Military-Industrial Investment Company, and Viktor Vasilyevich Berezhnoy, who are board member and director respectively of the new company.

Berezhnoy comments that "it's no secret that centralized financing of defense sectors of industry has been sharply cut, if not halted completely. We believe that a highly interesting intellectual, economic, and technological potential, is concentrated precisely in these industrial sectors. They could well be the engine that will pull our entire economy out of its current chaos. Thus, the idea is to create a kind of mechanism to allow us to survive, that will help us out of this dead-end. In essence, this means a structural reform of our country's military-industrial complex. Foreign experience shows that during structural reform, the role of investment houses and investment foundations grows, and these are the instruments that ensure the actual redirection of capital from one sector to another and at the same time automatically resolve societal problems, looking after self-interest in deriving maximum profit."

Gribkov continues by saying that the planned start-up capital for the business is about one billion rubles [R], of which R350 million have already been raised: partly in cash and partly in the form of rights to use buildings, communication equipment, etc. The company should be operational by the end of this year, and will at least initially invest heavily in setting up a commercial communications network carrying market-research data.

Gribkov adds that this network will also supply "information on the business climate in various regions of our country, on orders placed with defense structures that are now scattered throughout the former Union. This integrated network, in my opinion, within the framework of the military-industrial investment company, has real potential for rapid and successful development."

He continues: "Among the list of founders, you named unit No 57275. To the well-informed, and this is no longer any military secret, it's well-known that this unit is engaged in control systems for space communications vehicles. Since it's one of the founders, we plan to set up a significant space-communications business with its help. Our company plans to invest part of its capital in production."

Berezhnoy elaborates on investment plans: first, information networks; second, market infrastructure and services; third, share issues by and privatization of defense-sector enterprises as legislation permits; fourth, banking, exchanges, insurance, and other purely financial activities.

Gribkov continues by saying that both theoretical and practical work is under way for turning defense factories into private shareholders' companies and placing shares on the primary market. Two unnamed factories, one near Moscow and the other near Saratov, have already been lined up, he says. In the long run, the new company will branch out from privatization projects in the defense sector alone.

Organizations investing over R10 million will have preferential rights regarding policy-making and investment in projects that the company is involved in, explains Berezhnoy.

Gribkov adds that special attention will be given to investment in new technology and research, to make good shortfalls in central financing.

Shares in the military-industrial company defense-sector enterprises, Berezhnoy says, will be a safe hedge against looming hyperinflation and monetary devaluation, since they are backed up with hard assets. They will be a safe repository for state-issued "privatization coupons," for the same reasons. Asked what's in it for the defense complex itself, he replies: "The entire defense complex, to put it bluntly, could well be bought up by foreign companies. There's enormous interest. According to some evaluations, the ruble, the money used in our defense complex, is equal to the dollar in the U.S. defense complex. In these terms, in quality and intellectual potential, we are not lagging behind in this field. We do have a lot of technology that attracts U.S. industrialists." Gribkov explains that the ruble-dollar valuation has been deliberately arrived at by using the old Central Bank commercial rate.

Next, Gribkov sets out the way in which the new company will issue shares: initially in blocks of 100 at R100,000 per block, then 12-18 months later single shares at the same price of R1,000 for the ordinary worker. Shares can be held in common by syndicates of workers. He continues that due to defense cuts, many ordinary workshops producing, say, pieces of artillery, are now standing idle. Their plans will allow factories to diversify, finding clients for new civilian products.

Berezhnoy picks up on this: "Not necessarily new products. I wouldn't like our conversation to give the impression that we're involved solely in converted defence enterprises, because we're not. We're involved in the defense complex in its entirety."

Gribkov says: "That's a very important qualification. The fact is that we're trying very hard to attract orders from the West, from Britain, France, the United States. But third world countries in Latin America and Africa are showing huge interest in our production base. For them, our defense-complex products are very interesting, because they're reliable and simple to use. For their level, they're just what's needed. And we're trying to create a way of matching the client to his ideal manufacturer. There are already specific projects, although it would be premature to speak of their implementation, but it's already clear that returns will be very high and this will be of interest to both client and manufacturer."

Berezhnoy concludes the item with a discussion of the relative values of the ruble to the Soviet defense industry and the dollar to its U.S. counterpart industry: "Where the production base and the intellectual base are concerned, then of course our ruble is undoubtedly of no less value than the dollar".

Gribkov confirms that one of the new company's aims is to halt the slide in the value of the ruble on the domestic market, affirms his confidence in the economic and industrial potential of the USSR, and laments the industrial and cultural "decay" of the country.

'Political Instability' Causes Brazil To Drop Contract for Satellite Launch

LD0211135491 Moscow Radio Rossii Network in Russian 2100 GMT 30 Oct 91

[Excerpt] A report from the RIA. Due to the hazy political future of the former Soviet republics, Brazil has declined to conclude a contract with Glavkosmos to launch its first artificial Earth satellite. The contract, worth over $30 million, would have been advantageous. This was reported by Edson Machado, secretary of science and technology of the Brazilian Government. He stressed that the possibility of obtaining Soviet space technology and the launching of a satellite by a Soviet rocket were very attractive. However, taking account of the USSR's political instability, the Brazilians switched to the U.S. firm Orbital Corporation. [passage omitted]

Space Authorities Deny Rumored Offer to Sell Space Program Elements

PM0411171591 Moscow KOMSOMOLSKAYA PRAVDA in Russian 2 Nov 91 p 2

[D. Babich report: "'Mir' to the White House?"]

[Text] According to French weekly L'EXPRESS, representatives of the Soviet "space leadership" have unofficially approached Americans with an offer to sell or lease several key elements of the Soviet space program.

Powerful engines, a satellite control center, the "Soyuz" spaceship, and even the "Mir-2" orbital station which is to replace the "Mir-1" station currently in operation are all included on the list of items for sale.

The Soviet "Mir-2" station could, if refitted, replace the U.S. "Freedom" orbital station, which is currently in financial difficulties. According to the French magazine, the launch cost of "Mir" has been set at $600-700 million. As for "Soyuz," it is intended to be used, where necessary, to bring astronauts back to earth from U.S. space stations in an emergency.

REUTER reported 30 October that NASA has refused to buy "Mir," preferring to develop its own "Freedom" system.

We put our questions about this nonexistent deal to Glavkosmos [Main Administration for the Creation and Utilization of Space Technology] and to the "Energiya" Science and Production Association that developed "Mir." Glavkosmos refused to comment on the situation, saying that if it was a question of any deals with the Americans, it was only a question of joint use of Soviet complexes. Yet they rightly added that it would look very

bad to sell things that have been developed with the people's money. The "Energiya" Science and Production Association announced that nothing had been sold to the Americans and that everything indicates that Glavkosmos leaked incorrect information.

Glavkosmos and the "Energiya" Science and Production Association have always been considered among the country's most secret organizations. Therefore their leaders' belated denials seem quite strange: It looks as though U.S. congressmen and NASA have seriously discussed a deal that was "never proposed." Why is that?

Baykonur Cosmodrome to Become Commercial Association

LD0711173891 Moscow TASS in English 1925 GMT 6 Nov 91

[Text] Leninsk November 6 TASS—A commercial association—"International Spaceport"—is to be established on the basis of the Baykonyr Cosmodrome in the Soviet Union, it was announced here.

The association will offer potential users services in taking their cargo to space using Soviet booster-rockets Proton, Soyuz, Zenit and Energiya.

The new firm is to be an open type joint-stock society founded by the Kazakhstan Space Research Agency, major commercial investment banks and the Space Rocket Associations of Russia and the Ukraine.

Eighty per cent of shares will be distributed among the founders, the remaining 20 will be sold freely. It is expected that private capital will take part in the establishment and in subsequent activities of the space port.

According to Sergey Sopov, a spokesman for the Kazakhstan Space Research Agency, the international space port will be able to compete with the European Arianespace consortium and the leading aerospace companies of the United States and China on the market of services in sending up to space all kinds of spacecraft.

Utkin Opposes Space Program Fragmentation

927Q0027A Moscow KRASNAYA ZVEZDA in Russian 5 Nov 91 p 4

[Interview with academician Vladimir Fedorovich Utkin, general director of the Central Scientific Research Institute of Machine Building, by M. Rebrov; place and date not given: "Sovereignization of Space Research? This Is an Absurdity"]

[Text] **Let us state candidly that the situation is extremely strange. The Baykonur Cosmodrome is located on the territory of Kazakhstan, while the most powerful scientific and production potential of the space sector is located on the territory of Russia. If we announce that this is all Russian property, all the sovereign republics will lose. If Kazakhstan insists that "the cosmodrome is ours and our alone" then the next question is this: "Who will fund this enormous test complex with fixed capital worth 6 billion and how, and how will it even be maintained?"**

This problem was also the subject of our correspondent's interview with the general director of the Central Scientific Research Institute of Machine Building—the country's leading space center—general designer for space rocket equipment, academician Vladimir Fedorovich Utkin.

[Rebrov] Vladimir Fedorovich, the country is in a euphoria of "sharing." Today, everything is being made "mine" and "yours" whether or not it is a divisible thing. Land and factories, electric power station and ports, cultural monuments and... in short, everything. We may assume that the space above a city or oblast or republic will fall under the jurisdiction of a new sovereign formation. How do you assess this prospect?

[Utkin] It is difficult for me to say how this process will develop, but I am convinced that we should be oriented primarily on common sense and international standards and agreements. Space is for the entire planet, and before "sharing" space programs and space research in general, we must decide what the national, fundamental, and applied programs and projects are and what investments are required for them.

Take the cosmodrome at Baykonur, which was built using money from the entire country. How can it be assigned to a category of "mine?" There is no need to lapse into ambition and vanity. Haste is not the best helper in this complicated business especially since it affects everyone's interests—Russia, Kazakhstan, the Ukraine, and any other republic, sector, etc.

[Rebrov] The fever of sovereignization has already spread to space research. This "disease" threatens to become chronic, but perhaps the most important thing is that the interests of space research itself are not being taken into account.

[Utkin] Unfortunately this is true, and it is not only Kazakhstan that intends to set up its own space agency. Russia is also preparing to do this. The general designer of the Energiya Scientific Production Association has stated that the collective of this scientific production association owns the Mir orbital station. Tomorrow we can expect that those who are developing communications and navigation satellites and satellites for studying natural resources will be doing the same thing. It is like a chain reaction; it just has to start, but in fact many design and production collectives, essentially the entire country, have participated in the design, manufacture, and outfitting of the various kinds of equipment and other space technology. If we follow these arguments further, then the entire nation has experienced certain deprivations from the cost of the space programs.

[Rebrov] It is not only we who are spending a good sum on space research. Every country that is engaged in space

research carries considerable expenditures. Each American taxpayer provides about $120 from his own pocket, while an inhabitant of West Europe pays about $9.

[Utkin] Those are the figures cited in the press, but I would like to talk about something else. While they have seized certain technical space facilities (the cosmodrome, launch facilities, assembly and test premises, ground measuring facilities, etc.), and along with them a certain amount of space activity, the new owners are not thinking about how to fund and organize the work, and this is a problem that will not go away. Maintaining Baykonur costs a great deal, but neither should we forget something else: As I have already said, in order to pursue space programs it is not only launch facilities that are needed but also a command and measuring complex, a control center, etc.

Sovereignization of space research is an absurdity. You must understand that big projects like space communications, meteorology, navigation, cartography, and natural resources, will have a palpable effect only given precise coordination and cooperation. In one orbit a satellite "looks at" enormous areas—"one's own" and "others." It turns out to be unprofitable if it is "servicing" just one region. That is not difficult to see.

[Rebrov] Vladimir Fedorovich, we like to blame the West; we say that they are acting in a different way, but we do not want to learn.

[Utkin] Yes, we like to do that. I recently visited the United States where they have a single national space program, and the space centers at Cape Canaveral or the space center in Houston are not the property of any particular state but of NASA—the National Aeronautics and Space Administration. The European countries are also acting wisely; they have combined their technical and financial potential in the European Space Agency—ESA. We could create something like that here. It would be a rational step since something on the order of more than 2,000 enterprises in the country are working in the space industry. Space research makes up 1.5 percent of GNP.

[Rebrov] A final question, Vladimir Fedorovich. You are a USSR people's deputy and have worked in one of the Supreme Soviet committees. Does our country need a law on space research—a single law that covers and regulates all directions of activity in this field?

[Utkin] Without a doubt it is needed, and the sooner it is passed the more effectively and sensibly many legal, scientific, technical, and ecological issues can be resolved.